POWER PLANT ENGINEERING

Established Over 30 Years

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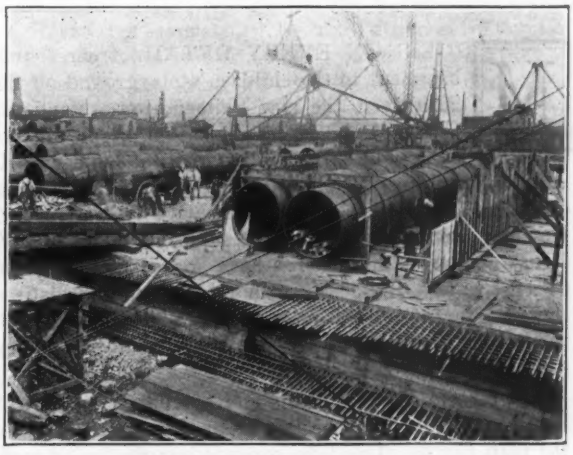


A Necessary Evil

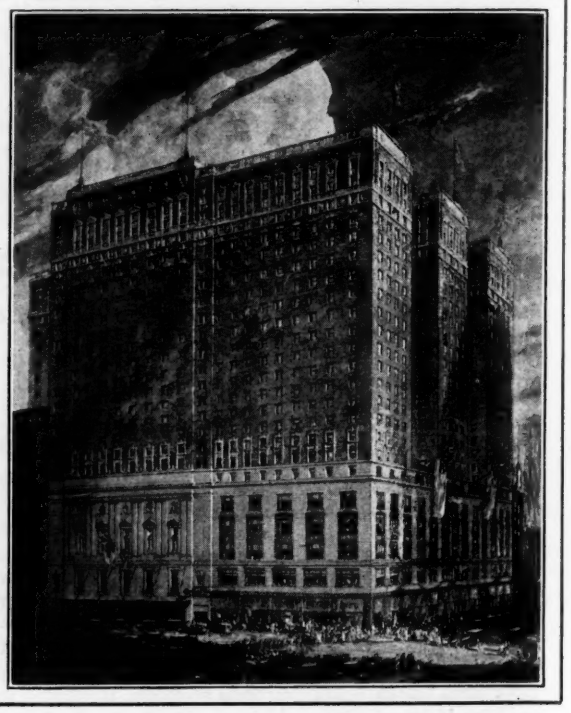
PAYING ANYWHERE from three to six dollars a ton for coal and then deliberately throwing three-quarters of it away may not sound like good business, yet anybody familiar with condensing steam plants knows that it is. For it is by discharging 75 per cent of the heat in the coal in the condensing water that we are enabled to utilize from 20 to 25 per cent instead of from 5 to 10 per cent of the total energy in the fuel. So while the condenser water discharge is in one sense an evil, it must at the same time be regarded as a necessary one.

That this question of getting rid of low level heat is important can be seen from the illustration at the top of this column which shows the condenser water intake and discharge tubes for the new East River station of the New York Edison Co. Over 800,000 gal. of water will flow through these tubes every minute, fully twice as much water as the great Catskill acqueduct brings into New York City.

The design of intakes and discharge conduits for handling such immense quantities of water naturally presents many problems, not only as to construction details but also as to the most suitable location, with respect to the water level in the lake or river from which the water is drawn. Since this last question has received considerable attention of late you may be interested in the article on the subject appearing on page 898 of this issue.

New Palmer House Serves Chicago Visitors

MODERN POWER PLANT OF 2580 B.HP. HELPS MEET EXACTING DEMANDS OF ONE OF AMERICA'S FINEST HOTELS



MODERN IN EVERY DETAIL, from fourth basement to the children's playground on the 25th floor, the new Palmer House stands as Chicago's latest monument of hospitality to the public. Backed by years of hotel experience, the architects, Holabird & Roche, and their chief engineer, J. A. Sutherland, working with W. L. Gregory, manager and the mechanical superintendent, T. V. Brush of the Palmer House, have spared no effort and expense to take the dozen or more separate and distinct services, for which the power plant is responsible, and weld them into a single well-coordinated unit. Thompson-Starrett Co. were the builders.

As far as possible, heating and ventilating equipment has been grouped in the sub-basement, as indicated in the plan Fig. 5. This level extends into the boiler room at about the same elevation as the heater gallery, the relative location of the various floors being well brought out by the boiler room elevation, Fig. 4. House pumps, fire pumps, compressors and boiler feed pumps are grouped back of, and at the same level, as the boilers in the third basement. As shown in the plan Fig. 1, the Illinois tunnel comes in on this level and is utilized for ash removal, the ash tunnel, coal conveyor, blowoff tank and sewage ejectors taking up practically the entire space in the fourth basement.

Saturated steam at 125 lb. per sq. in. is furnished by four 645-hp. Brunswick-Kroeschell Co. three-pass boilers, each served by a Green chain grate stoker with an area of 165 sq. ft. Stokers are designed for a continuous boiler rating of 200 per cent when burning 10,000 B.t.u. coal. Vertical King refractories monolithic boiler baffles are used throughout and automatic combustion control is maintained by a Hagan regulator which regulates the stoker speed through a variable speed Louis Allis Co. motor or an E. H. Wachs Co. steam engine. All stokers are driven from one line shaft by either the motor or engine at the discretion of the engineer.

Each boiler is equipped with Marion Machine Foundry & Supply Co. soot blowers, Copes feed-water regulators and pump governors and Republic steam flow meters. Natural draft from a steel stack 9½ ft. in diameter and 365 ft. high is used on all boilers, operating conditions being shown by Republic draft gages, pyrometers and CO_2 meters. Outside air is available through alley openings and in order to supply the large quantities of air necessary for combustion without creating drafts through stairways and corridors, certain fans exhausting from public spaces in the hotel are arranged to discharge directly to the firing aisle.

COAL AND ASH HANDLING SYSTEM

During normal operation coal is received by motor truck and discharged from the alley directly to the concrete bunkers from which it is fed by means of a 1500-lb. Link-Belt Co. weigh larry direct to furnace hoppers. Ash is pulled twice a day from the ashpits and carried by a Link-Belt Co. 18 by 21-in. pivoted bucket conveyor to a small ash hopper located over the tracks of the Illinois tunnel. In order to make the conveyor and driving mechanism as noiseless as possible, two silent chain drives are used instead of the usual arrangement of one silent chain and one set of spur gears. Horizontal runs of the conveyor measure about 121 ft. with a vertical lift of 44 ft.

In case of a surface tieup, coal can be received by subway, delivered through a chute to the lower run of the bucket conveyor and distributed to the overhead bunkers. Bunkers were designed to hold a ten days' supply of coal and are so arranged in relation to the conveyor that it is possible to transfer the coal from any part of the bunker to any other part where coal may be needed. An additional four days' storage is provided below in the dead storage space served by the conveyor. Ash may be handled by a Brady Conveyors Corp. steam jet ash conveyor or in an emergency can be taken to the ground level in the freight elevators.

Two-inch coal screenings running about 12,000 B.t.u. as received, are being used, estimated consumption varying from 700 to 1800 t. per mo. depending upon the time of year. Samples are taken each day and a composite sample analyzed by the chemist once a week.

Provision has been made for an estimated electric load of 6579 kw. made up of 2715-kw. motor load, 2864-kw. lighting load and an additional 1000 kw. allowed for exterior lighting, sign lighting or future extensions. This power is handled by a General Electric Co. switchboard consisting of 21 black slate panels complete with instruments.

No Power Is Generated in Hotel

All electric power is purchased from the Commonwealth Edison Co. which in the Chicago Loop district is limited to direct current at 110 and 220 v. Space limitations, the excessive cost of excavating and other considerations during early stages of design led to the abandonment of the plans for power generating units. Subsequent operation shows that under these specific conditions of power costs and heat balance control of the hotel, the arrangement is both satisfactory and economical. Steam and electric auxiliaries are installed in duplicate so that the steam units can be cut in as the demand for low pressure steam increases. During periods of heavy heating load, high pressure steam is used direct to the low pressure system through Boylston Steam Specialty Co. reducing valves.

All water used in the hotel is taken from the city mains, metered by two Neptune Meter Co. meters and filtered through four International Filter Co. horizontal sand filters with a total filter capacity of approximately 75,000 gal. per hr. Each filter is 7 ft. in diameter and 16 ft. long and is cleaned about twice a month by back-flushing. International coagulant feeders are provided at the entrance to the filters in order to treat the water with alum, or other chemicals, in order to assist the filters in removing suspended matter.

From the filters the water is pumped to general service tanks on the 15th and 26th floors. The low level tanks are supplied by either a 4-in., four-stage, motor-driven centrifugal or a 17 by 10 by 15-in. pot-valve steam pump, while water for the higher level is pumped by a 5-in., four-stage, motor-driven centrifugal or a 20 by 12 by 15-in. pot-valve steam pump. All four pumps furnished by the Worthington Pump & Mach. Corp. are equipped with Smolensky Valve Co.'s noiseless check valves and controlled by a Sundh Elec. Co. automatic control operating through float switches in the tanks. Reliance motors are used on the two motor-driven units.

Hot water is provided by six Patterson-Kelley Co. closed hot-water heaters with a total heating surface of 3524 sq. ft. Two heaters 84 in. dia. by 216 in. are used for high level, two 84 in. dia. by 168 in. for low level and two 54 in. dia. by 168 in. for kitchen supply service. Powers Regulator Co. thermostatic temperature control is used in all six with the temperature maintained at 165 deg. F.

Boiler feed water passes to a Cochrane 60,000 gal. per hr. combined feed-water heater and V-notch meter where it is heated to about 200 deg. before being delivered to the boilers by two Worthington 12 by 7½ by 15-in. pot-valve boiler feed pumps.

Drinking water is filtered through three International disk filters and purified by an 1800-gal. per hr. ozone purifier built by the Electric Water Sterilizer & Ozone Co. The water is then cooled to about 42 deg. F. by direct expansion coolers and circulated through the sys-

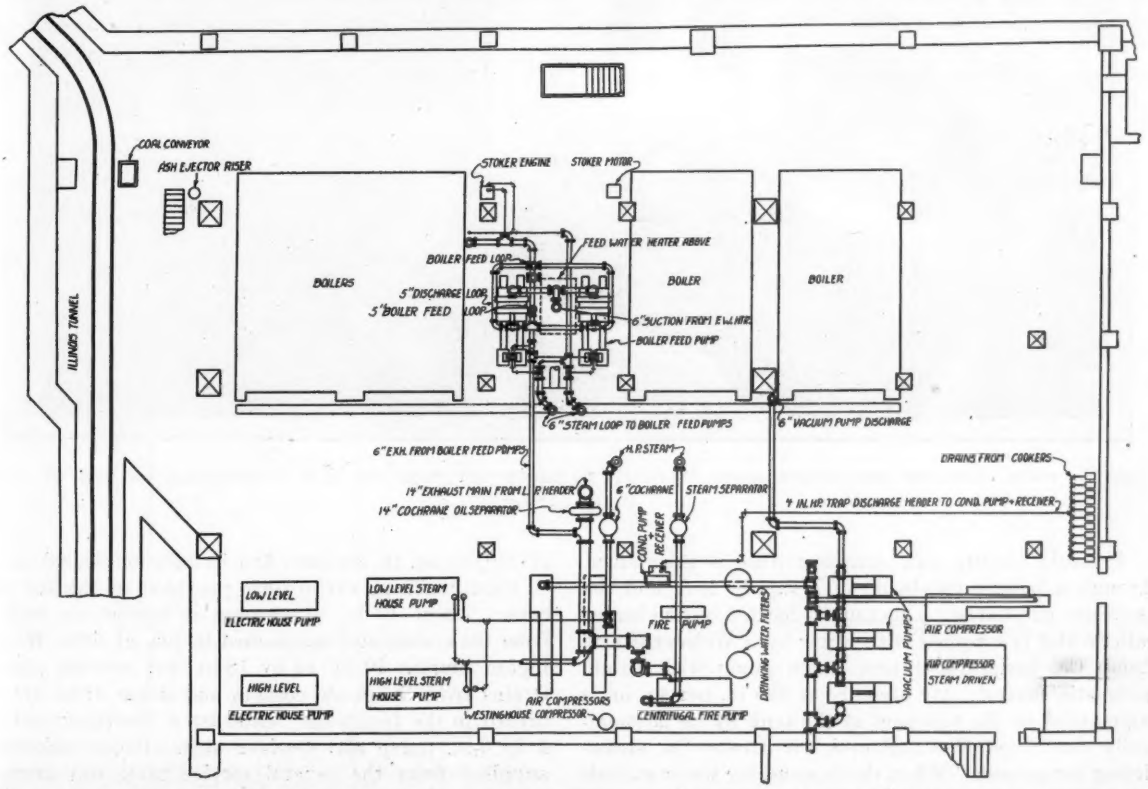


FIG. 1. BOILER ROOM EQUIPMENT HAS BEEN ARRANGED WITHOUT CROWDING TO GIVE THE MAXIMUM AMOUNT OF CONVENIENCE IN THE MINIMUM AMOUNT OF SPACE

tem by Worthington Triplex pumps driven by Reliance motors. A 5 by 8-in. and a 4 by 6-in. pump, each driven by 7½-hp. motors serve the high and low level systems, respectively, while a 5 by 8-in. pump with a 10-hp. motor is piped as a standby to either of the other two.

Fire Protection Is Important Part of Plant

The local fire signalling system is so arranged that, when an alarm is turned in two service elevators go immediately to the sub-basement to pick up the local fire crew and apparatus. Fire drills are frequent.

g.p.m. centrifugal fire pump driven by a 75-lb. steam pressure, 300 hp., 1800-r.p.m. Standard Turbine Co. turbine.

Low pressure vacuum system heating with Warren Webster Co. traps is used throughout, a pressure of less than one pound gage being sufficient to heat the entire system in the coldest weather. Above the fifth floor steam is supplied from down feed lines from a receiver and distributing mains while the fifth floor and below is supplied by risers from the sub-basement. American Radiator Co. radiators with a total direct radiating surface

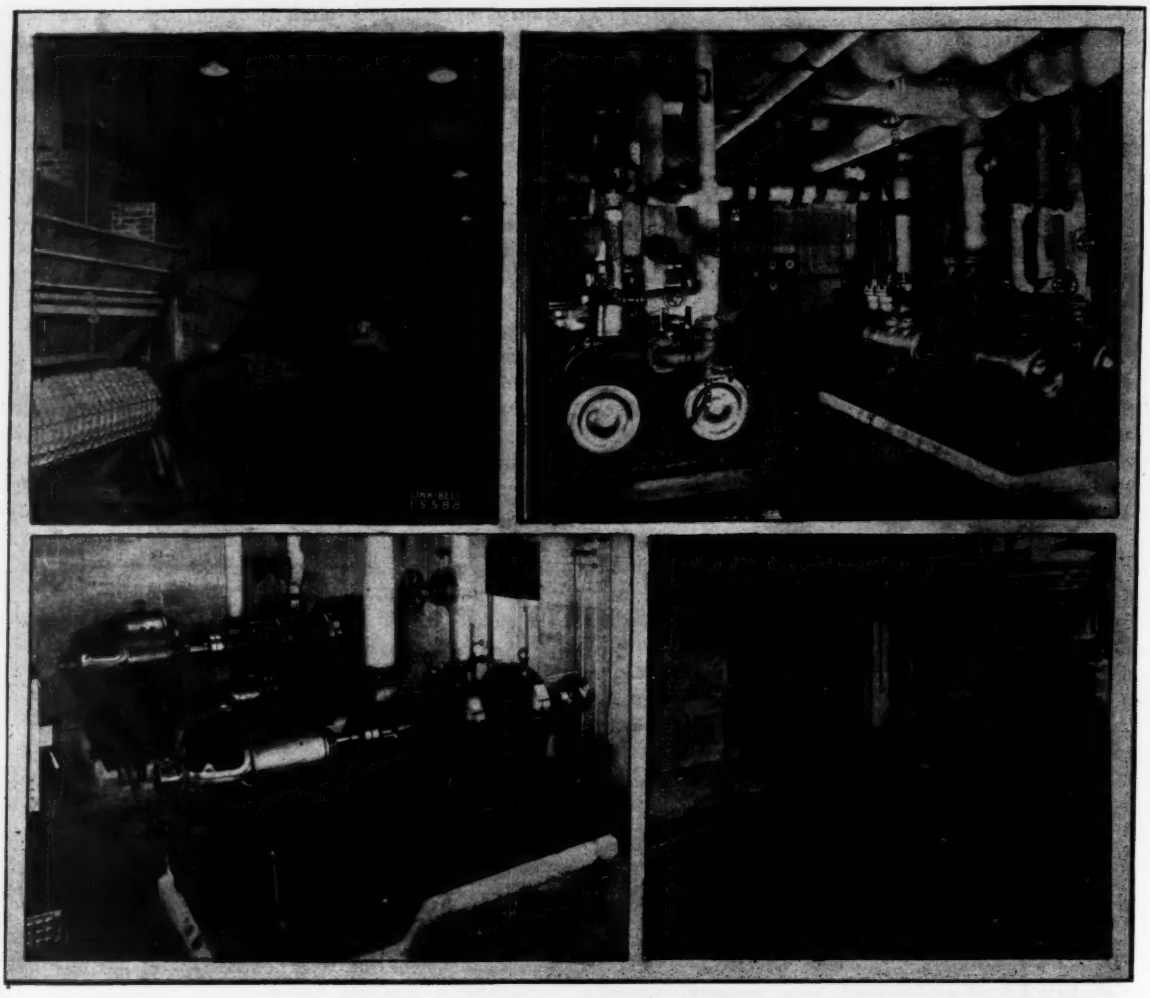


FIG. 2. FOUR VIEWS OF THE BOILER ROOM SELECTED TO BRING OUT SOME OF THE INTERESTING DETAILS OF THE INSTALLATION

Pressure on fire and sprinkler lines is maintained through a booster consisting of a supply tank and the necessary auxiliaries. This tank is located on the heater gallery and is supplied with water by a Webster Steam Pump Co. horizontal duplex steam pump with Sundh automatic control. Air pressure at 235 lb. per sq. in. is maintained on the top part of the tank by an automatically controlled Westinghouse Air Brake Co. steam-driven compressor. When the demand for water exceeds the supply of the small pump, the decreased pressure automatically cuts in a Dayton-Dowd Co. five-stage, 1500-

of 150,000 sq. ft. are used and in addition 35,000 sq. ft. of blast radiating surface are provided in the fan systems. About 10 in. of vacuum is carried on returns from the system and maintained by one of three Worthington simplex 10 by 16 by 18-in. wet vacuum pumps. Drains from the steam cookers and steam drips are returned to the feed-water heater by a Worthington 6 by 4 by 6-in. pump and receiver unit. Boiler makeup is supplied from the general service tank and averages about 15 per cent. General service traps were supplied by the Boylston Steam Specialty Co.

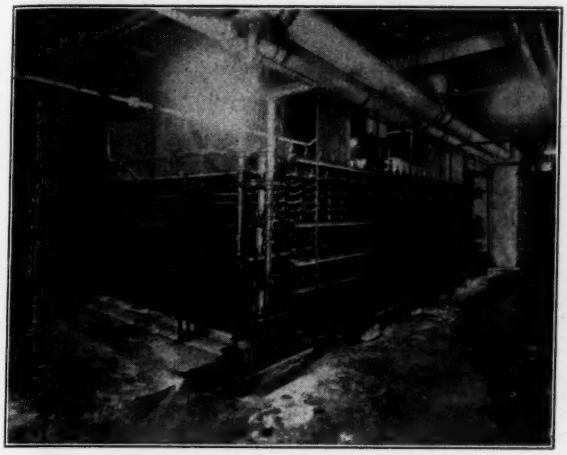


FIG. 3. THE CONDENSERS HAVE BEEN INSTALLED WITH EXCEPTIONALLY LIBERAL HEAD ROOM

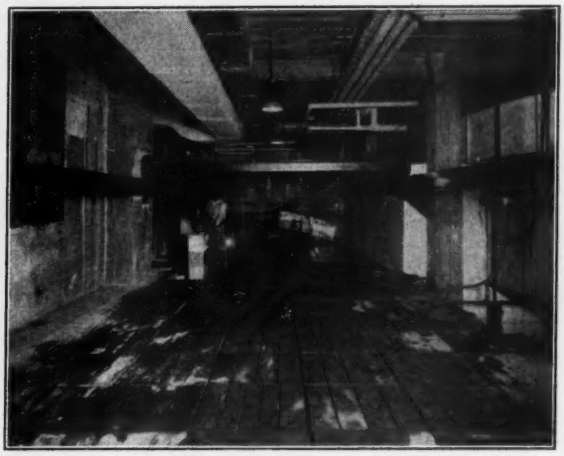


FIG. 4. ALL ICE USED IN THE HOTEL IS MADE IN THIS ICE TANK 11 CANS WIDE AND 20 CANS LONG

Ventilation is taken care of by 58 Clarage Fan Co. Multiblade fans with Reliance motors and 21 Clarage Type V air washers. The total capacity of the supply fans is 510,000 cu. ft. of washed air per minute, while the exhaust fans, located in various parts of the building have an additional capacity of 515,000 cu. ft. of air per minute. Washing water is supplied to the air washers by individual Dayton Dowd Pump Co. centrifugal pumps with a combined capacity of about 3600 g.p.m. Housings and pans of the air washers are of concrete and equipped with lead eliminators to offer greater resistance to corrosive action of the water. Fans and fan motors are mounted on sound-proof foundations, constructed of wood, hair felt and cinders, to effectively deaden noise and vibration. All dining rooms, offices, shops and corridors below the seventh floor are ventilated by fresh air being drawn in through openings above the fourth floor level. Exhaust from kitchens is carried to the roof in heavy sheet-iron stacks in order to reduce the fire hazard. In summer, air supplied to the lobby and to all dining rooms and banquet halls can be cooled approximately 10 deg. below the outside temperature by direct expansion coolers.

CO_2 Refrigeration System Used

Refrigeration and ice-making requirements are met by four CO_2 compressors: a 150-t. unit consisting of an 8 by 28-in. Brunswick-Kroeschell compressor driven by

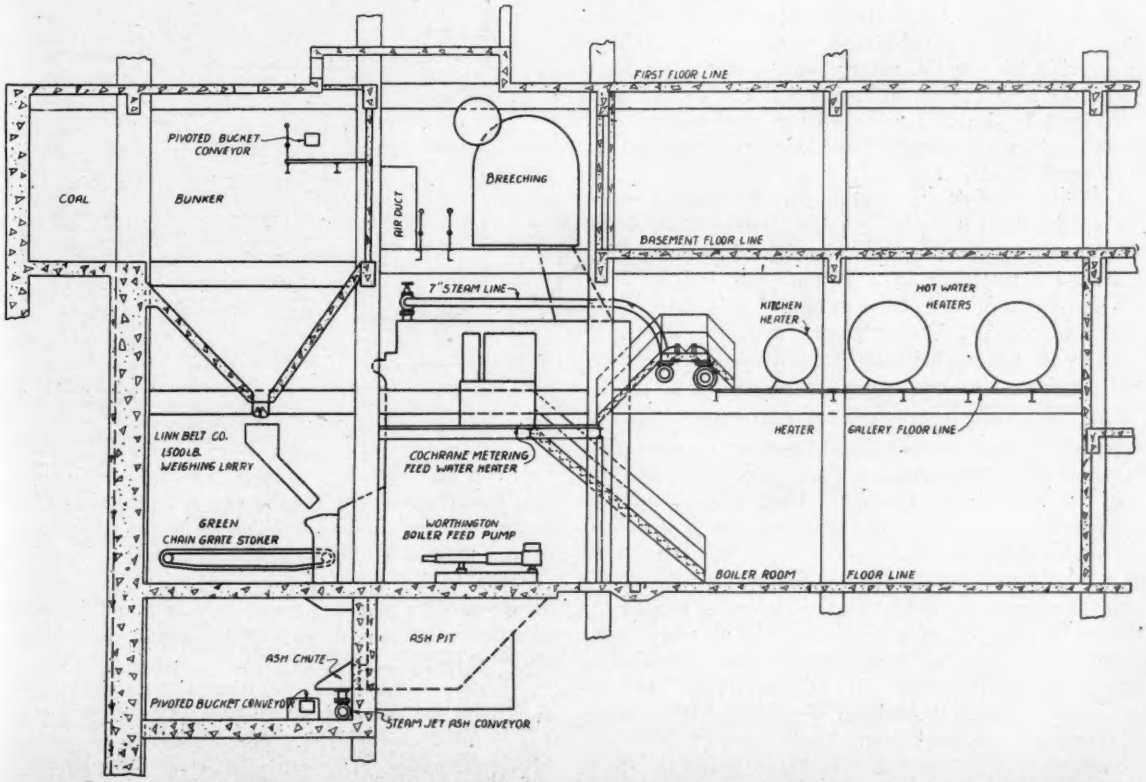


FIG. 5. ELEVATION OF BOILER ROOM BRINGS OUT THE SIMPLICITY OF THE COAL AND ASH HANDLING SYSTEMS

a direct-connected 22 by 36-in. Murray Iron Works tandem compound steam engine; a 20-t. Wittenmeier Machine Co. compressor belted to a 50-hp. General Electric motor; and two 80-t. Brunswick-Kroeschell Co. compressors belted to 125-hp. General Electric motors with push-button control.

Brine is circulated by a 500-g.p.m. Dayton-Dowd Co. centrifugal pump driven at 1150 r.p.m. by a 25-hp. motor or by a Worthington 10 by 10½ by 12-in horizontal duplex steam pump. Ice consumption averages about three tons per day, the maximum capacity of the plant being 220 three hundred-pound cakes in 24 hr. Two Connorsville Blower Co. rotary pumps driven by 3-hp. motors are used for air agitation while a similar unit driven by a 1½-hp. motor is used for core pulling. All motors used in refrigerating service were furnished by the General Electric Co.

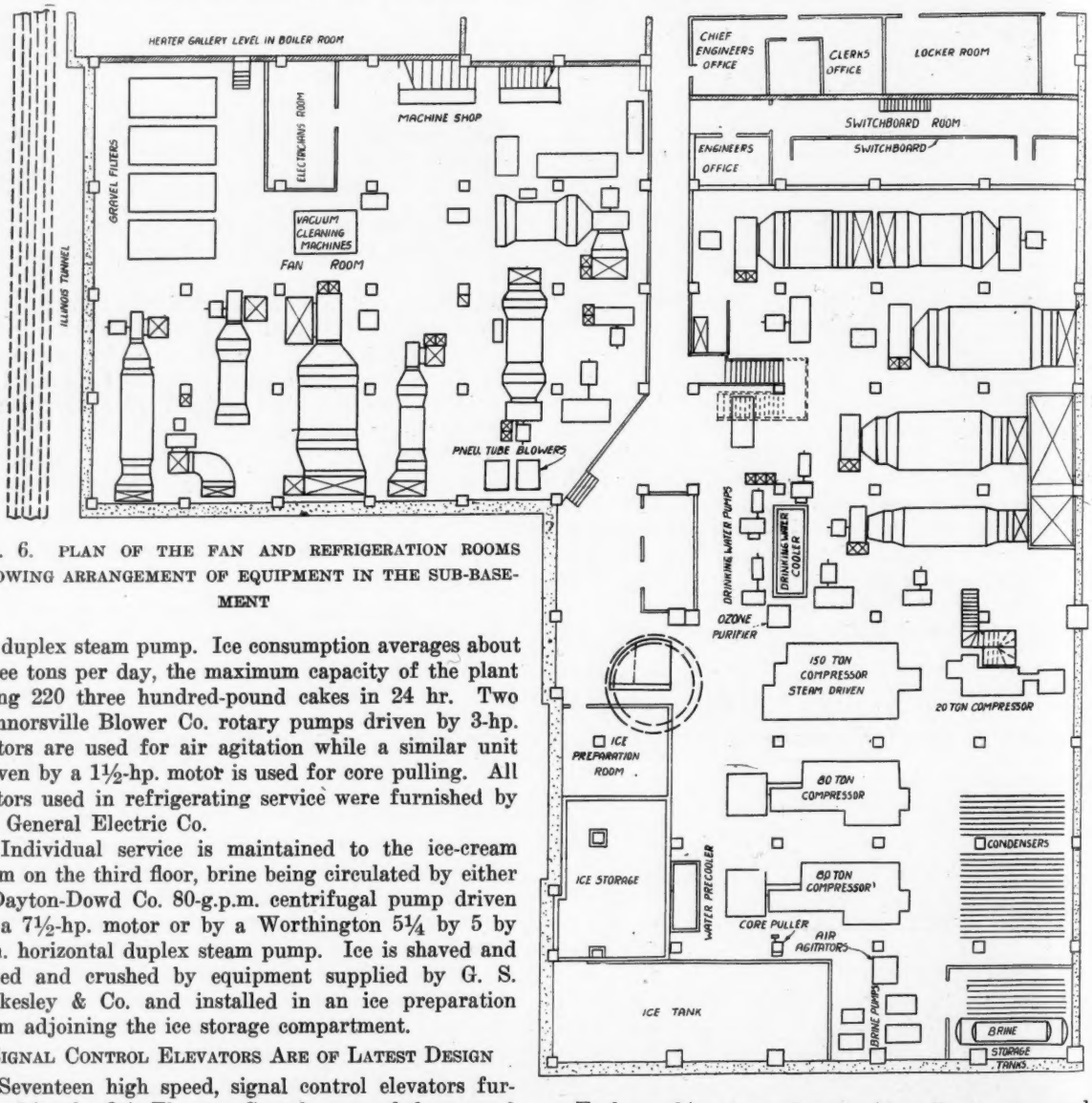


FIG. 6. PLAN OF THE FAN AND REFRIGERATION ROOMS SHOWING ARRANGEMENT OF EQUIPMENT IN THE SUB-BASEMENT

Individual service is maintained to the ice-cream room on the third floor, brine being circulated by either a Dayton-Dowd Co. 80-g.p.m. centrifugal pump driven by a 7½-hp. motor or by a Worthington 5¼ by 5 by 5-in. horizontal duplex steam pump. Ice is shaved and cubed and crushed by equipment supplied by G. S. Blakesley & Co. and installed in an ice preparation room adjoining the ice storage compartment.

Signal Control Elevators Are of Latest Design

Seventeen high speed, signal control elevators furnished by the Otis Elevator Co. take care of the general passenger and service demands. Each car is equipped with individual multi-voltage motor-generator sets, solenoid brakes and micro-levelers. The normal speed of 700 ft. per min. is maintained with any load from zero to the maximum of 2500 lb. Operation is almost entirely automatic, the sole function of the operator being to operate the controller to start the car, which automatically closes the doors. The cars are stopped at landings by the passenger pushing the signal button or by the operator pressing buttons in the cars and the cars automatically stop level with floor landing and the doors open.

Starting signals from the lobby are given automatically by a Boardman Elevator Control Co. automatic control and the starting sequence of cars speeded up as traffic demands require. Location of cars are shown at all times on an electric position indicator and a "tell tale" shows the floors where passengers are waiting. A "call back" is installed which permits the starter to signal the operator to bring the car directly to the lobby without intermediate stops.

Each machine is equipped with mileage, stop and trip recorders, which have shown as high as 4500 stops and 55 mi. travel by a single car in 24 hr. Average conditions show about 100 stops for each mile of travel. In addition to the eight-passenger and nine high-speed service elevators, seven slow-speed cars are used for kitchen and pantry service. Two elevator maintenance men are on duty each shift.

Compressed air for operating the elevator doors is furnished at 50 lb. by two 12 by 12-in. Ingersoll-Rand Co. duplex motor-driven compressors equipped with Maxim silencers. In addition to these an 8 by 10½ by 12-in. Ingersoll-Rand Co. steam-driven duplex and a 14

by 10-in. duplex motor-driven compressor furnishes air at 55 to 60 lb. for operating four 400-g.p.m. Yeomans Bros. Co. Shone sewage ejectors located in the fourth basement. The motor-driven compressor is driven by a 75-hp. Reliance motor. A 1000-g.p.m. vertical Yeomans Bros. Co. open impeller bilge pump driven by a Terry Steam Turbine Co. 40-hp. turbine at 1600 r.p.m. is used to drain the basement or, in an emergency, handle sewage overflow from the ejectors. Garbage is dropped through a chute from the sub-basement direct to two

Form 702 **PALMER HOUSE** CHICAGO

Engineer's Department
Partial Daily Quantitative and Cost Report

Date July 10 *1926*

	Today	*Yesterday*	Month *Ago*
Total Coal	19.88 *Tons*	17.89 *Tons*	17.04 *Tons*
Boiler Coal	18.29	16.23	15.90
Incin. Coal	1.59	1.66	1.14
Total Cost			
Boiler Cost			
Incin. Cost			
Steam	315 700 *Lbs*	257 480 *Lbs*	225 478 *Lbs*
Actual Evap.	8.63 *Lbs*	7.92	7.1
Cost-M Lbs.	*$0.*	*$0.*	*$0.*
Blown Down	7 475 *Lbs*	8 520 *Lbs*	9 120 *Lbs*
Make Up	34 650 *Lbs*	30 800 *Lbs*	25 900 *Lbs*
% Make Up	11.0	12.3	11.5
Av. B. H. P.	416	340	298
Water	40 300 *C.F.*	44 000 *C.F.*	43 900 *C.F.*
Gas	58 700 *C.F.*	62 900 *C.F.*	68 400 *C.F.*
Light	7 760 *K.W.*	8 410 *K.W.*	9 200 *K.W.*
Power	8 000 *K.W.*	9 100 *K.W.*	11 100 *K.W.*
Total	15 760 *K.W.*	17 510 *K.W.*	20 300 *K.W.*
Av. Outside Temperature	63.6 *°F.*	66.0 *°F.*	69.6 *°F.*
Coal on hand	439.61 *Tons*	408.69 *Tons*	491.51 *Tons*
Ice Made	3.3 *Tons*	3.3 *Tons*	4.95 *Tons*
Refrigeration Effect	*Tons*	*Tons*	*Tons*

FIG. 8. A COPY OF THE DAILY REPORT GIVING A SUMMARY OF THE DAY'S OPERATION COMPARED WITH TWO PREVIOUS DAYS

Morse Boulger Co. incinerators which consume about one ton of coal a day.

Vacuum cleaning service is supplied throughout the building and a vacuum of about 8 in. maintained by two Spencer Turbine Co. centrifugal units driven by 30-hp. Reliance motors. Exhaust from the system is carried directly to the boiler breechings. An extensive Standard Conveyor Co. pneumatic tube messenger system is installed and served by four Spencer blowers, two units located on the top floor and two in the sub-basement. Each of these four units is driven by a direct-connected 15-hp. Reliance motor.

Automatic telephones supplied by a 40-v. storage battery are used for all interdepartmental and service calls throughout the building. The Loyal Order of Moose, Station WJJD, maintains a broadcasting studio on the top floor, while an extensive system of loud speakers connect all public assembly and dining halls so that speeches, either from inside or outside the building, may be relayed, and amplified as desired.

Very complete records are kept and a summary of the previous day's operation made up each morning by the engineer. This statement, Fig. 8, shows not only the current date but gives records of two previous days as well. Complete daily and monthly statements are

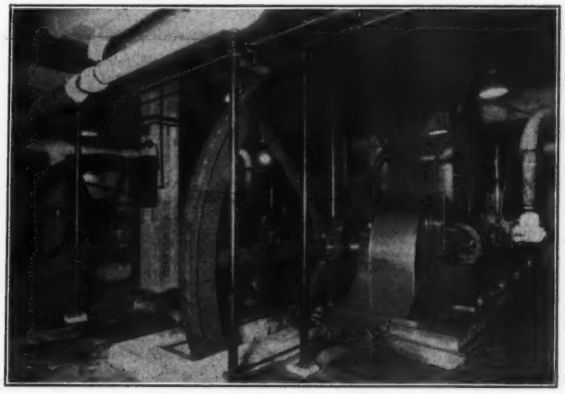


FIG. 7. GENERAL VIEW OF THE COMPRESSOR ROOM WITH THE 150-T. COMPRESSOR IN THE FOREGROUND

compiled by the chief clerk showing the cost of labor and material issued to "Heat, Light and Power," also "House Repairs and Maintenance." All mechanical work throughout the building is under the supervision of the mechanical department and the smoothness with which the plant and hotel were put in service without annoyance or discomfort to the guests, is a credit to the organization and reflects the superintendent's foresight in recruiting the operating force almost entirely from among men who installed the equipment, taking advantage of their intimate knowledge of the installation.

Muscle Shoals Power

SECRETARY OF WAR Dwight F. Davis has reached an agreement with the Alabama Power Co. for utilizing the power from Muscle Shoals until Dec. 1 and longer, if mutually agreed upon. Hydro-electric power will be supplied at 2 mills per kw-hr. when supplied in place of steam-electric power from the Gorgas plant, 3 mills per kw-hr. when substituted for the Gadsden plant power and 4 mills when substituted for Nitrate No. 2 plant power. For export to other company systems, the rate will be 2 mills.

Rates were fixed with a view to fairness to the power company as well as cost of producing steam power at the various plants and maximum return to the government for power which would otherwise be wasted as the Shoals plant is still being operated on best run. Under the old agreement the government received $119,000 for power developed. Under the terms of the new agreement, it would have received $145,000 for that power.

Data on Zeolite Water Softeners

PRINCIPLES INVOLVED. METHODS OF DETERMINING QUANTITIES OF SALT AND ZEOLITES NECESSARY. DESIGN DATA. BY T. J. ESS

WHILE THE PROCESS of softening water by the base-exchange method is comparatively simple, it seems to be shrouded by a certain amount of mystery. In this article we will therefore try to bring out the principles of the process, together with certain characteristics involved.

As is well known, the process consists of passing the water through a bed of zeolite sand in a suitable containing tank. Zeolite sand, while marketed under many

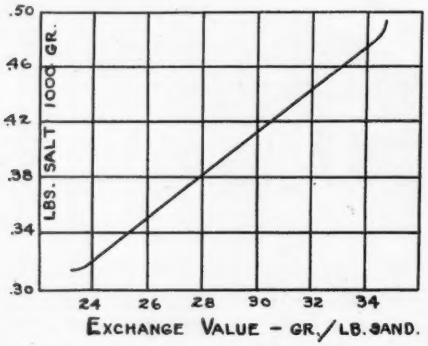


FIG. 1. CURVE SHOWING SALT REQUIREMENTS FOR VARIOUS EXCHANGE VALUES OF NATURAL GREEN SAND

different trade names, is a bi-metal silicate, either sodium-aluminum silicate or sodium-iron silicate, in which the sodium is in such condition that it can replace the calcium and magnesium in the water. The replaceable sodium in the zeolite is a definite quantity for that particular zeolite, and when water containing salts of calcium and magnesium passes through a bed of zeolite, an equivalent amount of the calcium and magnesium is exchanged for the sodium, forming calcium and magnesium "zeolite," while the soluble sodium salts remain in the softened water.

ZEOLITES

The natural zeolite used in this type of softener is a green marl sand found in large deposits along the Atlantic coast, having a specific gravity of about 1.7. This sand, screened, washed and dried, is ready for use, although some users process it in various ways with a view to making it more hardy.

There are also synthetic zeolites in use, made in many different ways. These zeolites are porous, and therefore have a higher exchange value than the natural sand, but in some cases difficulty has been experienced with them losing their exchange value.

The exchange value of green sand is usually rated about 2800 grains per cu. ft. of sand, or about 27 grains per lb., while the synthetic zeolites have been made as high as 10,000 grain per cu. ft., although the commercial synthetic types seldom exceed 5000 grains per cu. ft.

Although the life of a charge of zeolite is said to be over 20 years, alkalinity in the form of normal carbonates and hydrates tends to disintegrate the zeolite. Therefore, extremely alkaline waters may require some acid treatment before entering the zeolite softener. Also, over-running a zeolite, that is, working it beyond its normal capacity, is apt to break down its exchange qualities although an exhausted zeolite can sometimes be restored by boiling it in a salt solution. Other conditions tending to disintegrate the zeolite are acidity in the water, or free CO_2, and high temperatures.

REGENERATION

When all the sodium in the sand has been replaced by the calcium and magnesium in the water, it becomes necessary to regenerate the unit. This is accomplished by washing the sand thoroughly with a solution of sodium chloride (Common Salt), which displaces the calcium and magnesium, reviving the zeolite. Letting the brine stand in the tank seems to produce no appreciable benefits, the exchange apparently being instantaneous.

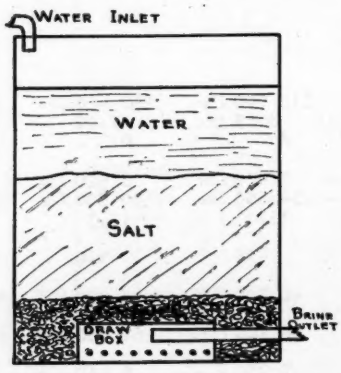


FIG. 2. SHOWING CONSTRUCTIONAL FEATURES OF THE BRINE TANK

The salt required for regeneration can easily be found from the curve in Fig. 1 and the formula:

$$M = \frac{Q \times H \times t}{1000} \times S \quad \ldots\ldots\ldots\ldots (1)$$

where M = pounds of salt per regeneration.
S = pounds of salt per 1000 grains as taken from the curve for the corresponding exchange value.
Q = gallons of water per hr.
H = hardness of water in grains per gal.
t = hours between regenerations per unit.

Small units are worked toward the top of this curve, but in larger installations, where the cost of the salt becomes an important item the lower values are used.

The size of the brine tank can be such as to hold sufficient salt for several regenerations. The usual method of construction is shown in Fig. 2. The draw box is placed in the bottom of the tank and surrounded with gravel, upon which the salt is placed. Water is run in, and passing down through the salt, forms a saturated brine, which is taken off through the draw box. The level of the salt in the brine tank can be lowered just enough to give sufficient brine for each regeneration. (2.64 lb. of salt per gal. of water required for a saturated solution.)

Before a unit is regenerated, it should be thoroughly back-washed with a flow of 6 to 8 gal. of water per sq. ft. per min. and after regenerating, rewashed until free from brine. This rewash is important, inasmuch as the brine is apt to cause very serious corrosion. If the pressure of the wash water is excessive, the zeolite is liable to be washed out of the softener and so wasted.

Design Data

If the system must operate continuously, two units must be installed in parallel, so that one may be regenerated while the other is in operation. If the system can be shut down for regeneration one unit will suffice.

In the smaller sizes, the tank units are vertical, while in the larger sizes, the tanks are placed horizontally.

The amount of sand in each unit will depend on the quantity of water to be softened, its hardness, the length of time desired between regenerations and the exchange value of the zeolite. Therefore:

$$W = \frac{Q \times t \times H}{F} \qquad (2)$$

where W = pounds of sand in each unit.
F = exchange value in grains per pound of sand.
Q, t, and H have the same values as in Formula (1).

Values of Q, H, and t are dependent on the installation. Values of F may be taken as 27 to 30 for natural green sand, and up to 45 for the commercial synthetic zeolites.

Having thus found the weight of sand required, the volume can be obtained, since the sand weighs about 105 lb. per cu. ft. The tank capacity should be about twice the volume of the sand, so as to allow for an open space above the zeolite bed and a gravel bed below the zeolite. One-half inch pea gravel, covered by a layer of sand is used for this gravel bed.

The cross-sectional area of the tank, as in all filters, is dependent on the rate of flow. Various values are used here, ranging from 3 to 6 gal. per sq. ft. per min., usually favoring the lower values. Roughly:

$$A = \frac{Q}{200}$$

where A = sq. ft. of filtering area
Q = gal. of water per hr.

With the cross-sectional area and the volume of the tank known complete dimensions are easily determined.

In the larger sizes of zeolite softeners, provision must be made for distributing the water evenly over the surface of the zeolite bed, as well as for the collection of the softened water below the bed. This can be accomplished by the use of a perforated pipe on the inlet, and by an evenly spaced collecting system on the outlet, thus preventing channeling of the zeolite bed.

Figure 3 shows the results of several tests run with a natural green sand softener of this type, supplying feed water to a small hand-fired boiler operating at about 100 per cent rating. The exceedingly high salt rate of test No. 2 produced no appreciable result, showing that only a definite amount of the sodium is interchangeable. Considering the working range of the softened water to be 3 grains or under, it will be seen from the curve that each 100 lb. of sand softened about 120 gal. of water of 28 grains hardness. Then $120 \times 28 \div 100 = 33.6$ grains per lb., the exchange value of the zeolite. From the curve in Fig. 1, the salt rate corresponding to this is about .47 lb. per 1000 grains. Then $.47 \times 3360 \div 1000 = 1.58$ lb. of salt per 100 lb. of sand for each regeneration. The actual rate used is 2 lb. of salt per 100 lb. of sand. This difference is due in part to the zeolites being actually worked at a higher exchange value, and also to the fact that the brine system for regenerating had no draw box, so that a certain amount of salt was wasted.

From chemical analyses taken in a similar test, it was found that, as the zeolite becomes exhausted and the hardness of the water rises, the carbonates, or temporary hardness, remain in the water, while the sulphates are exchanged, thus removing the permanent hardness of the water first. This fact is advantageous in that it permits running over the usual working range of the water without producing hard scale. Also, as in all

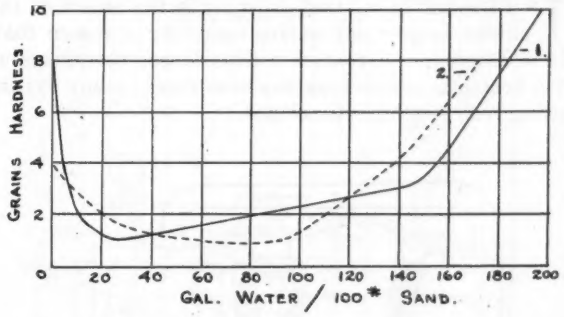


FIG. 3. CURVES SHOWING RESULTS OF TEST ON A ZEOLITE SOFTENER WITH 4000 LB. OF SAND PER UNIT, AND WITH 28 GRAIN WATER

No. 1 Average rate of flow—916 gal per hr. 2 lb. salt per 100 lb. sand for each regeneration.
No. 2. Average rate of flow—1300 gal per hr. 8 lb. salt per 100 lb. sand for each regeneration.

softeners, if there is an accumulation of scale in the boiler, the constant use of a properly softened water will cut this scale loose, permitting it to be easily washed out.

The cost of softening water by the zeolite process is very moderate, running from 3 to 8 cents per 1000 gal. softened. The repairs and maintenance of this type are extremely low. The cost of salt varies with different localities, and this item constitutes the main operating expense. The labor, which is limited to regenerating the units, requiring about one-half hr. for each regeneration, can often be taken care of by the regular boiler house men, which eliminates this item from the softening cost.

It is to be noted that the zeolite process of softening water does not remove the salts from the water but simply converts them into the soluble sodium salts. The following gives the results of these reactions:

1 grain $CaHCO_3$	=	1.035 grains $NaHCO_3$
1 grain $CaSO_4$	=	1.045 grains Na_2SO_4
1 grain $CaCl_2$	=	1.053 grains NaCl
1 grain $MgHCO_3$	=	1.15 grains $NaHCO_3$
1 grain Mg_2SO_4	=	1.181 grains Na_2SO_4
1 grain MgCl	=	1.23 grains NaCl

From this table the amount of dissolved solids carried by the treated water can be determined. If the raw

water supply carries a great deal of salts to be thus exchanged, the treated water will have a correspondingly great amount of dissolved sodium salts. If this water is then used in boilers operating at high ratings, priming is apt to occur, due to the high degree of concentration of these salts. There has accordingly been some hesitation in using zeolite softeners for supplying feed water to boilers operated at high ratings where the raw water carries over 15 grains of salts to be exchanged. In such cases it seems to be advisable to use a partial pre-treatment of lime or lime-and-soda-ash, and after filtering, pass the partially treated water through the zeolite softener to complete the process.

There have been instances of marked corrosion due to gases dissolved in the water on installations having zeolite softeners and closed feed water heaters. This is easily overcome by the use of either a deaerator or an open feed water heater, and it is advisable to remember this point when installing a zeolite softener.

With this process of water softening, the danger of over-treatment, which might come as a result of either the human element entering in other processes, or a variation of the raw water supply, is eliminated, and the treatment becomes automatic. Also, the first cost of the equipment, as well as the operating charges, will be less than with chemical treating plants.

Diphenyl Oxide Bi-fluid Power Plants*

THERMODYNAMICS OF PROPOSED BINARY VAPOR PLANT INDICATE A FINAL THERMAL EFFICIENCY OF OVER 34 PER CENT. BY H. H. DOW†

IN PRESENTING this paper, it is the object of the author to give particulars regarding a system that, it is believed, will convert a little larger percentage of the heat into power than has been done by any system using coal heretofore developed.

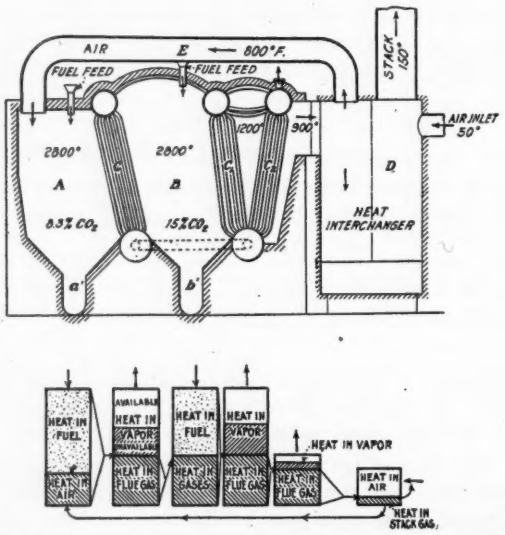


FIG. 1. TWO-STAGE COMBUSTION SYSTEM FOR STEAM BOILERS

According to thermodynamic principles, the highest efficiency of conversion of heat into power that can be obtained between given high and low temperature limits is that of the Carnot cycle, and is given by the equation

$$\frac{T_1 - T_2}{T_1}$$

where the temperatures are measured on the absolute scale and where all heat is put into the working fluid at the highest temperature T_1 and removed at the lowest T_2.

In practice for T_2 we are usually limited to 70 deg., since this is about the lowest temperature to which a fluid can be expanded in a power plant. At the upper end of the scale we are also limited, and, until the advent of the new chromium steel, it was impossible for a superheater pipe to withstand more than 725 deg. F.

In the accompanying table even where we get the high efficiencies of 80, 93 and 95 per cent in certain steps, the Carnot cycle efficiency is only 45 per cent. All these steps are so near 100 per cent that there is little opportunity of improving them. For this reason we may conclude that practically the only way of getting more horsepower from a heat unit is to go to a higher temperature at the upper end of the heat cycle, that is, increase the Carnot cycle efficiency. This requires that all of the heat be put into the fluid at the upper temperature limit of the cycle, which has not always been fully realized by engineers in general. In a boiler plant provided with an economizer they will consider the B.t.u. that go into it in the same sense as if they had gone into the original boiler.

SOURCES OF LOSS DUE TO NOT PUTTING IN HEAT AT TOP OF CYCLE

We are also limited in other ways. The modern plant for example, with its steam superheated to 750 deg. F. does not absorb the bulk of the heat from the coal at that temperature. If the steam pressure were in the neighborhood of 700 lb. per sq. in. the water would boil at about 500 deg. F. and most of the heat from the coal would be utilized at this temperature. We should then have a Carnot-cycle efficiency corresponding to 500 deg. as the upper limit and 70 deg. as the lower limit, which is approximately 45 per cent. This would be increased only a small amount by superheating, because the amount of heat absorbed as superheat is relatively small.

This 45 per cent is decreased materially in an ordinary plant because part of the heat in the coal has to raise the temperature of the condensate from 70 deg. to the boiling point at 500 deg. There is a way, however, to circumvent this loss, namely, by the so-called bleeder system, whereby steam that has already been utilized to a certain extent in a steam turbine and has lost some of its heat, is extracted therefrom to heat the boiler feed water. Here only heat that has been put in at the top of the heat cycle is utilized to raise the temperature of the condensate nearly to the temperature at which the water is boiling. This method of bleeding, if carried out in an infinite number of steps, would make the Rankine cycle and the Carnot cycle exactly the same.

*An abstract of a paper presented at the A. S. M. E. session of the annual meeting of the Assn. of Chemical Equipment Mfrs., Cleveland, O., May 14, 1926.

†President, The Dow Chemical Co., Midland, Mich.

In practice, the method can be carried out only imperfectly; that is, the B.t.u. that are absorbed by the boiler have only about 90 per cent of the value they would have if they were absorbed at 500 deg. in the examples cited.

The other loss in a power plant, namely, that incurred in heating the air from the outside temperature to that of the stack, can be largely eliminated by a heat interchanger.

Proposed Remedies

Preheated Air

A number of systems using preheated air have been developed, and while many of them are successful when employing comparatively low temperatures, there are certain practical objections to utilizing air at a temperature of more than 300 deg. for combustion. It is one of the objects of the present paper to describe a practical way of overcoming one of these objections.

By means of a heat exchanger constructed at Midland and operating on the same principle as the heat regenerator in the Siemens open hearth steel furnace, gases are taken from the furnace and discharged to the atmosphere at about 100 deg. above the temperature of the surrounding air. The heat lost by the flue gases is given up to fresh air entering the heat exchanger which is then sent into the furnace. This device recovers a large percentage of the total heat; in fact, theoretically, it can put more degrees into the entering air than it took out of the gases because of the fact that the outgoing gases contain a larger percentage of steam—due to combustion of the hydrogen in the coal.

The main feature about such an apparatus is this: Instead of absorbing the lower-temperature heat in economizers, where the Carnot-cycle efficiency with which that heat is used is only 15 to 20 per cent, the heat of the stack gases is returned to the furnace to be absorbed by the boiler at the highest temperature of the cycle.

In an ordinary power plant, it is the author's experience—and that of many others—that 14 per cent CO_2 gives decidedly more trouble than 13 per cent. At 13 per cent CO_2 the heat is distributed through one-thirteenth more air than at 14 per cent CO_2, with the result that the temperature in the furnace is not as high. In the author's experience a lower power cost is obtained by running at 13 per cent CO_2 than at 14 per cent. There is a slight economy in coal consumption in going from 13 to 14 per cent CO_2, but it is more than counterbalanced by the increased repair bill.

Feeding preheated air at 800 deg. F. and then going to 13 or 14 per cent CO_2 in a furnace would add the 800 deg. to the temperature now attained with disastrous results. For this reason the author considers it necessary, or at least advisable, to adopt the following system of combustion.

Two-Stage Combustion

In this system, referring to Fig. 1, one-half the amount of coal to be burned is fed into furnace *A* at the top. Here it meets air from *E* at 800 deg. and it can well be imagined that the combustion will be rapid and good, as there will be a great excess of oxygen.

The gases then flow between the tubes *C*, where their temperature is reduced to 1200 deg. F. Next they meet the remainder of the coal coming into the second combustion chamber, *B*, and the temperature is again raised to 2800 deg., assuming that there is no radiation to the tubes. Thence the gases pass on, as in other boilers, through the tube banks C_1 and C_2, discharging at 900 deg. into the heat interchanger *D*. A 900-deg. stack-gas temperature would be quite fatal ordinarily — there would be a 20 per cent stack loss; but by using the heat interchanger and bringing back most of the heat, this loss can be brought down to 2 per cent.

A two per cent stack loss seems incredible, but it has been kept down to that in one installation at the author's plant for more than a year. The latest report on a second heat interchanger was 180 deg. F. stack temperature, the boiler operating at 200 per cent of rating. In this case a waste-heat boiler operated at atmospheric pressure to bring the temperature down as low as possible so that the temperature of the air going under the grate would not exceed 300 deg. F. because the stoker builders would not guarantee their stoker if that temperature was exceeded.

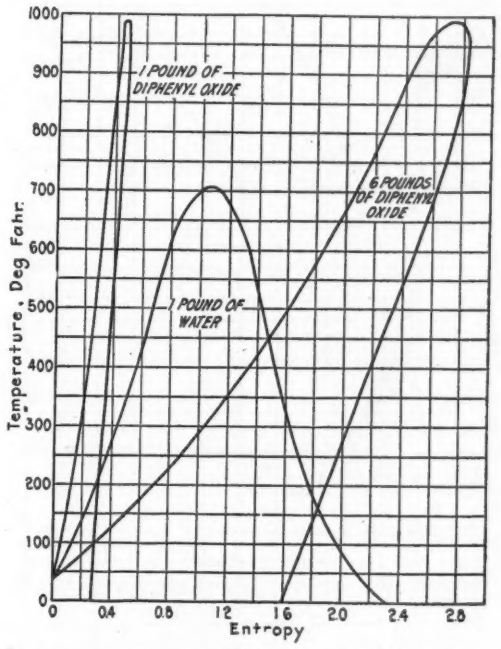


FIG. 2. TEMPERATURE ENTROPY DIAGRAMS FOR WATER AND DIPHENYL OXIDE

In the first interchanger installation a Newman stoker is used, the coal being blown in at a height of about three or four feet above the grate. Prior to the use of heated air under the grate it was necessary to spread the coal by hand once every hour or so, because holes formed, causing low CO_2 and inefficient combustion unless this was done; however, when the temperature of the air was raised to 300 deg., it was necessary to spread the coal only once in every 8 hr. If the air was raised to a temperature of 800 deg. and the coal dropped 10 ft. instead of about 3 ft., all the fuel would burn in suspension, even though it were not finely pulverized.

The author does not say, however, that there would not be more complications in the second combustion chamber, *B*, than in the first. Pulverized or partially

pulverized fuel may be required, but if the temperature is 1200 deg. to start with and a generous excess of oxygen is carried, fine grinding will not be necessary. It will probably be cheaper to increase the size of the heat interchanger and run at a lower CO_2 percentage than to grind to any great extent for the second furnace.

Efficiency of Plants Embodying Above Principles

Assume now a modern power plant with 680 lb. pressure but no superheat, using the bleeder system on the turbines to such an extent that the Rankine cycle becomes 90 per cent of the Carnot cycle. The steam temperature would be 500 deg. F. and the Carnot-cycle efficiency would be 44.8 per cent.

The next point is turbine efficiency, and in this assumed case it is only 75 per cent because the turbine is

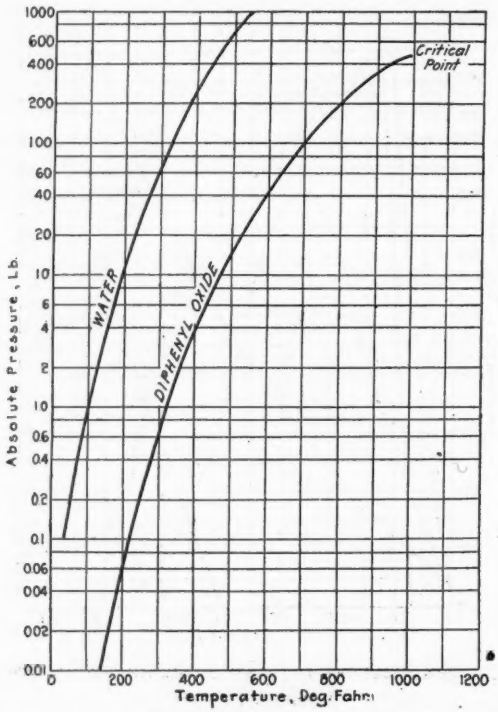


FIG. 3. VAPOR-PRESSURE CURVES FOR WATER AND DIPHENYL OXIDE

not working on superheated steam. (See column 1, table.) As the steam expands in the turbine, water is formed, and as nobody has yet found out how to make an efficient combination water wheel and windmill, the efficiency is naturally poor. The generator efficiency is 96 per cent, which is common in big generators. The boiler efficiency is 93 per cent. This may seem too high, but it corresponds to a 2 per cent stack loss instead of one of 10 or 15 per cent, and still leaves 5 per cent for radiation, which is a fair estimate for a big boiler, so 93 per cent is not out of the way. Then there is 5 per cent for auxiliaries, which leaves 95 per cent available. Multiplying all these together will give an overall efficiency of 25.65 per cent, which is equivalent to 13,250 B.t.u. per kw-hr., or less than one pound of coal per kw-hr. These figures are entirely reasonable, every step indicated having been accomplished in one plant or another.

The second column of the table gives figures for a plant somewhat similar to the Crawford Avenue plant in Chicago. In the latter plant, however, instead of the high temperature being 500 deg. F. corresponding to 681 lb. pressure, a pressure of 550 lb. is carried and the steam is superheated to 700 deg., and after partial use is again superheated to 700 deg. In the assumed plant for which figures are given in the table the steam is superheated in each case to 750 deg. F.

The only particular difference between this plant and the first one is that instead of having a 75 per cent turbine efficiency it has one of 82 per cent. This assumption is justifiable because here the wheel operates as a windmill on dry vapor all the while, due to superheating and resuperheating. The result is a total efficiency of 28.4 per cent, or 0.86 lb. of coal per kw-hr.

There is no practical way of going farther than this with steam alone; there is no gain in increasing the steam pressure.

If we desire to increase the Carnot-cycle efficiency by putting the heat in a steam plant at a higher temperature, say, at 2000 lb. pressure, we shall find that compared with the steam boiler where it is put in at

COMPARATIVE EFFICIENCIES OF STEAM AND DIPHENYL-OXIDE-WATER POWER PLANTS

	Steam Plants		Diphenyl Oxide-Water, 750 to 70 deg. fahr. (per cent) (3)
	500 to 70 deg. fahr. (per cent) (1)	500 to 70 deg. fahr., superheat twice to 750 deg. fahr. (per cent) (2)	
Carnot-cycle efficiency	44.8	45.4	54.6
Ratio of Rankine to Carnot cycle	90	90	90
Steam-turbine efficiency	75	82	83
Generator efficiency	96	96	96
Boiler efficiency	93	93	93
Percentage of power available (Total less percentage for auxiliaries)	95	95	94
Final thermal efficiency	25.65	28.4	34.2
B.t.u. per kw-hr.	13,250	12,000	10,000
Coal per kw-hr., lb.	0.95	0.86	0.72
Oil per kw-hr., lb.	0.74	0.67	0.35

700 lb. pressure, there will be a gain in the Carnot-cycle efficiency of 7 per cent.

Of that 7 per cent, 2 per cent will be lost because of the larger boiler-feed pump required. This will bring the gain down to 5 per cent. There will also be a loss because of the ratio of the Rankine cycle to Carnot cycle not being 90 per cent. That is, the same proportion of investment for bleeding and preheating will not give 90 per cent, but, say, 85 per cent, if working on 2000 instead of 700 lb. pressure. That will then wipe out the remaining 5 per cent and result in no gain at all.

It can be mathematically demonstrated that there is no other method available to increase materially the above-mentioned 28.4 per cent overall efficiency except by the use of a liquid that has a boiling point that is higher than that of water.

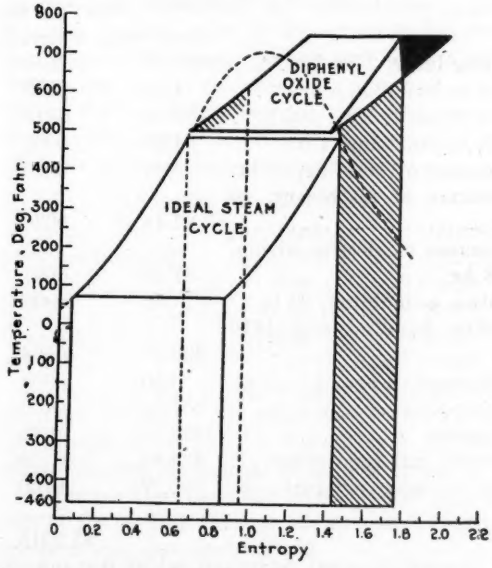
Diphenyl Oxide and Its Properties

Mercury has properties that are superior in many respects to those of any other substance. It is capable of being raised to a higher temperature than any other known liquid. Any organic material has a limit beyond which it will decompose, whereas there is no temperature at which mercury will not be mercury. Accordingly, it has an unlimited field, if a material can be found that will hold and use it at extreme temperatures.

This was clearly understood by the man who developed the bi-fluid system, Dr. Emmet; however, he failed to recognize the availability of the organic compound, which, so far as the author knows, has the highest boiling point with the greatest practicability, namely, diphenyl oxide. On the contrary, Dr. Emmet stated that it would decompose in a boiler. Now, the author's company happens to be the only manufacturer in the United States that makes diphenyl oxide on a large scale, and in its process of manufacture it employs a higher temperature than that at which Dr. Emmet thought it would decompose.

Accordingly, some of this diphenyl oxide was purified at various temperatures and it was found that it did not decompose under the proposed power-plant conditions, although it does if the temperature is made high enough, and the time long enough.

Diphenyl oxide is a white solid at room temperature, but a liquid if it contains a slight amount of impurity. It melts at 81 deg. F. when very pure. The fact that it is a solid is a slight objection, but any part of the boiler room where it would be used would have a temperature above 81 deg. Its specific gravity is 1.083 and its boiling point at atmospheric pressure is 258 deg. C. or 496 deg. F., which is the temperature of saturated steam at 680 lb. pressure.



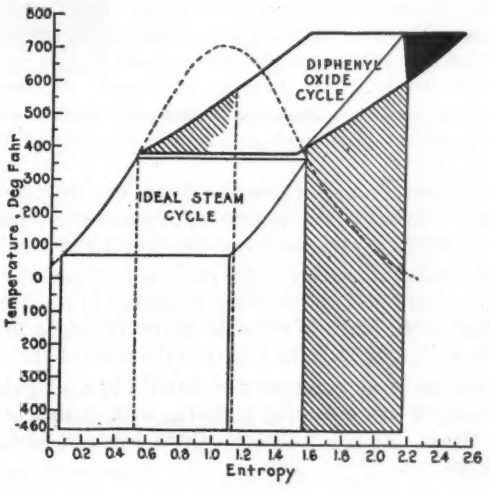
(Diphenyl oxide, 135 lb. to atmosphere; water, 600 lb to 29¼ in. vacuum.)

FIG. 4. TEMPERATURE-ENTROPY DIAGRAM FOR DIPHENYL-OXIDE BI-FLUID PLANT

At 200 lb. pressure its boiling point is 800 deg. F. Its specific heat is approximately 0.4. Its critical pressure is 465 lb. at a temperature of 530 deg. C. or almost 1000 deg. F. Another physical property not often recorded in the tables is its price. In quantity lots it is worth 30 cents a pound. It can be produced in unlimited quantities, and the cost per unit volume is less than 2 per cent of the cost of the same volume of mercury. This is one principal reason for advocating diphenyl oxide in bi-fluid power systems.

One of the thermodynamic properties of diphenyl oxide is that in an ordinary turbine where it expands adiabatically, instead of condensing like water it superheats to a marked degree, even in a 100 per cent efficient turbine. For example, when the vapor expands from 135 lb. gage down to atmospheric pressure where the boiling point is 500 deg. F., the temperature, instead of being 500 deg., is about 625 deg.

This extreme amount of superheating has an advantage and a disadvantage. It is difficult to transfer heat from a superheated vapor. Accordingly, when this vapor is exhausted at 625 deg. it is necessary to use it regeneratively to heat the boiler feed in order to get 90 per cent of the Carnot cycle, otherwise the efficiency of this cycle would be only 75 per cent. We have 15 per cent as the goal to be gained by using regenerative heating, that is, taking the exhaust superheat from the



(Diphenyl oxide, 135 lb. to 24 in. vacuum, water, 150 lb. to 29¼ in. vacuum)

FIG. 5. TEMPERATURE-ENTROPY DIAGRAM FOR DIPHENYL-OXIDE BI-FLUID PLANT

turbine and using it for reheating the boiler feed, which corresponds to bleeding in an ordinary steam installation. A certain amount of this can be done, but whether or not it can be brought up to 90 per cent without prohibitive expense, has not yet been demonstrated.

Another advantage of diphenyl oxide is that the weight of its vapor is about 9.4 times that of steam vapor. This means that a diphenyl-oxide turbine will run at a lower speed with higher torque for the same horsepower than a steam turbine, which is a great advantage. It may be that on that account we shall get a little higher turbine efficiency, and we shall certainly get some higher turbine efficiency by reason of the fact that there is never any condensate in the vapor.

One difference between diphenyl oxide and mercury is that the latter does not wet steel, and on this account the boiler tube may get much hotter than the mercury; whereas diphenyl oxide does wet the tube, so that it is easier to transfer the heat from the boiler to the liquid.

For these various reasons the author feels very confident in proposing the diphenyl-oxide bi-fluid plant working between 750 and 70 deg. F. The diphenyl-oxide vapor would be generated in a boiler at 135 lb. gage

pressure and expanded to a vacuum depending on the steam pressure with which it is desired to work. The temperature-entropy diagrams show two such combinations, one (Fig. 4) in which the diphenyl oxide is condensed at atmospheric pressure, making steam of about 600 lb. pressure, and the other (Fig. 5) exhausting at about 24 in. of vacuum, making steam of 150 lb. pressure.

The black area in each diagram represents the difference between the Rankine and the Carnot cycle in the proposed diphenyl-oxide cycle. The saturated vapor enters the turbine at 750 deg. F. and expands to the exhaust pressure with a temperature considerably higher than the condensing temperature. The superheat in the vapor, represented by the shaded area, is then removed in a counterflow boiler-feed preheater. The heat of vaporization at the condensing temperature is given up to the water in the condenser boiler and the liquid diphenyl oxide is returned to the boiler through the preheater. The steam should be superheated by direct heat or by diphenyl-oxide vapor in order to gain the increase in the efficiency of the turbine.

Powdered Coal Costs in Factory Plant

Ohio Brass Co. Keeps Detail Records of Coal Preparation Costs. By F. L. Wolf*

THE COAL pulverizing plant of the Ohio Brass Co. at the Mansfield factory was originally designed to pulverize 5 t. per hr. so that 85 per cent would pass a 200-mesh screen. At present, additional pulverizing equipment is being installed which will increase the capacity of the plant and give a total capacity of 10 t. per hr.

The plant furnishes coal for firing one 20-t. reverberatory furnace, six annealing furnaces having a capacity of 20 t. each, and two 350-hp. Stirling boilers.

Equipment necessary to pulverize 5 t. of coal per hr. shown in the schematic drawing is housed in a fireproof building 75 ft. long, 35 ft. wide, 42 ft. in height to top of side walls and 52 ft. in height to the peak of the roof.

The cost of an equipment to handle 10 t. of pulverized coal per hr., including building, such as that of the Ohio Brass Co., will run somewhere between $100,000 and $125,000.

Data secured from various sources on operating costs show a wide variation and depend upon those elements which the individual operator deems necessary to be considered when calculating his costs.

Cost data in the accompanying table were taken from the records of the plant and cover all of the elements which entered into the pulverizing of 8400 t. of coal during the year 1925. The items of interest on the investment and depreciation are not shown.

*Technical Superintendent, Ohio Brass Co.

Total coal pulverized	8400 t.
Total hours dryer operated	1186.75
Total hours mill operated	2086.00
Total tons of coal dried per ton of coal	128.05
Total hours operator worked	3704.00

Costs of Pulverizing	Costs	Cost per ton Coal Pulverized
Operating labor, 3704 hr.	$2398.46	$.2850
Repairs to building, 8 hr.	4.40	.0005
Repairs to machinery, 166 hr.	99.97	.0119
Repairs to plumbing, 4 hr.	1.95	.0002
Maintenance of building, 64 hr.	33.95	.0040
Maintenance of machinery, 46 hr.	27.48	.0030
Maintenance of electric wiring, 138 hr.	81.48	.0097
Alteration to building, 52 hr.	29.60	.0030
Unloading, handling coal, 1616 hr.	838.54	.0998
Miscellaneous, 6 hr.	3.50	.0004
Total supplies	337.33	.0400
Total power	5496.24	.6540
Pulverized coal for drying	424.44	.0500
Air for transporting coal	595.27	.0700
		$1.2315

In the metallurgical operations, which demand above all things "Quality First," it has been found necessary

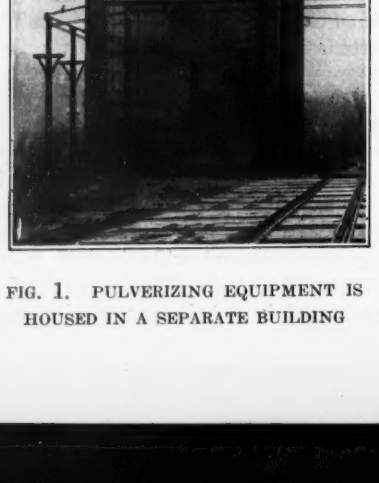


FIG. 1. PULVERIZING EQUIPMENT IS HOUSED IN A SEPARATE BUILDING

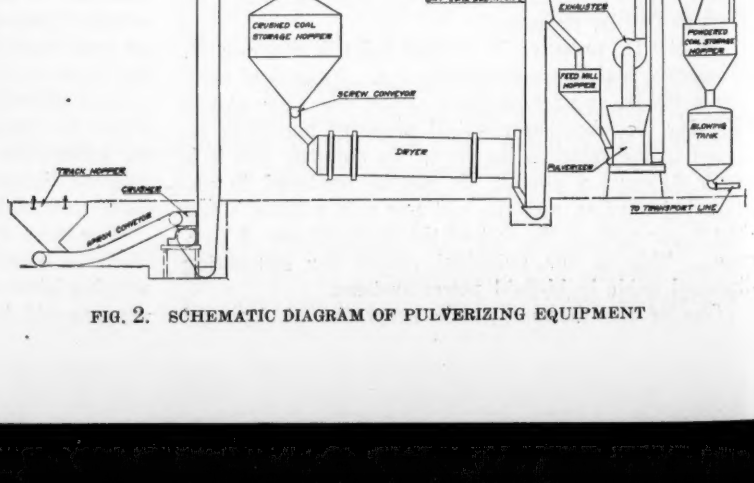


FIG. 2. SCHEMATIC DIAGRAM OF PULVERIZING EQUIPMENT

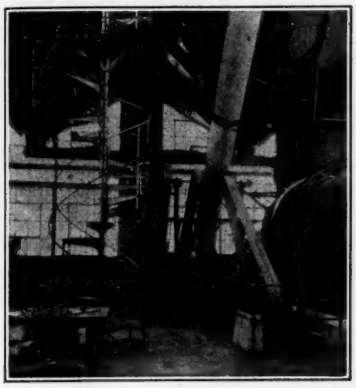


FIG. 3. TWO RAW COAL STORAGE HOPPERS FEED TO DRYER

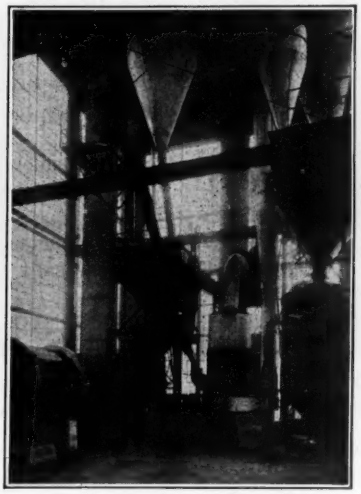


FIG. 4. LEFT. PULVERIZING MILL TAKES COAL FROM DRIED COAL HOPPER AND DISCHARGES TO DISTRIBUTING SYSTEM

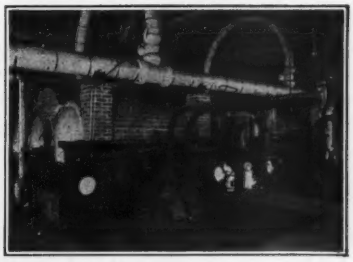


FIG. 5. PULVERIZED COAL FIRING EQUIPMENT USED AT THE BOILERS

to use the best quality of coal. For boiler operation there is still a question as to where the line should be sharply drawn; but it is the general feeling with us that the best quality coal is the cheapest in the end.

During the year 1925, two grades of coal were used which we shall designate as grade A and grade B. Average analyses of these coals are shown here:

ANALYSES OF COALS USED

	Grade A	Grade B
Moisture (as received)	2.74%	2.90%
Ash	3.50	6.50
Volatile	37.88	33.15
Fixed carbon	56.80	60.26
Sulphur	0.45	0.48
B.t.u.	14,000-14,500	14,000-14,500
Fusion point of ash	2584°F.	2550°F.
Specific gravity	.375	.4369

During the first six months of the year grade B coal was used for the most part, but on account of its erratic behavior at the melting furnace, its use was discontinued and grade A coal was used instead.

For firing the boiler, grade B coal gave good results but did not equal that given by grade A coal.

It will be noticed that there is little difference in the analysis of the two coals. They both carry the same heat units. The physical characteristics, however, showed considerable difference. Grade A was uniform, all lumps showing a uniform fracture and color. Grade B showed a difference in color and there was a marked difference in the fracture. Many of the lumps showed a stratified condition and an analysis of the various strata showed a considerable variation in composition. Following is the analysis of three strata in one lump picked at random.

	Strata No. 1	Strata No. 2	Strata No. 3
Moisture	1.94%	1.27%	0.59%
Ash	5.78	1.30	13.88
Volatile	33.23	32.89	30.45
Fixed carbon	60.26	64.54	55.08
Sulphur	0.59	0.29	0.31
B.t.u.	14,695	15,257	13,824

Other stratified lumps showed areas which, on analysis, gave an ash content as high as 33.42 per cent.

In the use of coal B a peculiar condition was noted. A precipitation took place on top of the metal bath. This precipitate was not a slag but a finely divided material, resembling flake graphite in appearance, which acted as a blanket. Following is the analysis of this material:

Silicon dioxide	23.31%
Iron and aluminum oxides	13.90
Calcium oxide	nil
Magnesium oxide	1.63
Fixed carbon	59.46
Volatile	0.76

The arrangement of the pulverizing equipment was such that the two grades of coal could not be separated; therefore, on account of the metallurgical requirements, it was necessary to standardize on one grade only and this grade was decided to be grade A. This coal comes from the Elkhorn district, Eastern Kentucky, and at no time has there been an erratic shipment received. The coal is remarkably uniform and check analyses are obtained from car to car.

The Lopulco system, manufactured by the Combustion Engineering Corp., is used, operating the boilers at a rating from 50 per cent normal to 200 per cent.

The brick work on the boiler settings is 32 in. in thickness provided with hollow wall space which provides a means for preheating the secondary air and also serves to protect the refractories.

The distance from the burners to the bottom of the combustion chamber is 21 ft. 6 in. A short distance above the bottom of the combustion chamber is a water screen, composed of 4-in. tubes, 80 sq. ft. in area. This not only helps to prevent the ash from fusing but also increases the boiler efficiency.

To date, after 27 mo. operation, the brick work in the boiler settings is in perfect condition. No repairs or replacements have been made.

Analysis of the waste gases shows a CO_2 content of

12.5 per cent. This could be raised to 14 per cent, but by so doing would probably mean a much more severe service on the refractories.

One fireman, per shift of 8 hr., operates the plant. This same man could handle a plant twice this size without any effort. Automatic signal lights show the operator just where his reserve water supply is and arrangements have been made so that he has three sources of supply available at his command.

Normally the ash is removed from the combustion chamber about once every 60 days. To remove the ash, the boiler must be taken out of service. It requires the labor of one man for a period of about 4½ hr. to remove this ash. On account of the nature of the coal burned, the ash is in an extremely fine state of division, is light brown in color and has never shown the slightest tendency to fuse. At one period, a run of 125 days was made before the boiler was taken off the line to remove the ash.

Both boilers are equipped with fuel oil burners which, in an emergency, can be placed in service in about 5 min.

With the use of powdered coal the boiler house is kept spotlessly clean and working conditions are ideal.

Extraction Turbine Fills Many Needs

INSTALLATION OF 1580-KV.A. MIXED PRESSURE EXTRACTION UNIT EFFECTS CONSIDERABLE SAVINGS IN INDUSTRIAL PLANT. BY S. B. ROBERTS*

IN THE SPRING of 1925 it became necessary for the Oil Well Supply Co. at their Imperial works at Oil City, Pa., to provide reserve power to carry the plant electric load in case of trouble to the existing 1200-kw., d.c., mixed pressure geared unit. Two old tandem compound, belted generators and one direct-connected natural gas engine unit totaled 550-kw. reserve capacity. The 350 plant motors are direct current machines and have a combined capacity of 3900 hp. Steam-using equipment in the factory which exhausts directly to the atmosphere consists of a steam elevator, steam pumps and steam engines on the test floors. The latter are tested exhausting to the atmosphere to meet manufacturing conditions. The tightness of various manufactured articles is tested with steam which is then lost. Exhaust steam returned to the system by the plant is obtained from eleven steam hammers in the blacksmith shops, and from seven engines which drive hot blast heater fans. These engines are occasionally run for short periods in the summer to improve ventilation. One 3520-c.f.m., cross compound Corliss gear, two-stage compressor furnishes air at 110-lb. gage pressure during the day and a 2525-c.f.m. machine with Meyer gear is run throughout the night. The plant uses air in the pneumatic moulding machines, bumpers, rams, air hoist, chucks, and similar equipment.

In a survey of the plant a saving was shown to be possible by generating instead of purchasing alternating current, provided that in the summer the available exhaust steam could be utilized for power generation, and in the winter that sufficient exhaust steam could be obtained for plant heating. The original idea of installing a reserve machine was enlarged to cover improvements suggested by the survey, such as changes in feed water piping, plant heating, and better use of exhaust steam from the auxiliaries and factory. These betterments added a little less than 6 per cent to the total cost and indicated that they would pay for themselves in one heating season.

In considering several types of generating equipment, it was found that the overall efficiency, above one-quarter load of an a.c. generator-converter outfit

*Plant Mechanical Engineer, Imperial Works, Oil Well Supply Co.

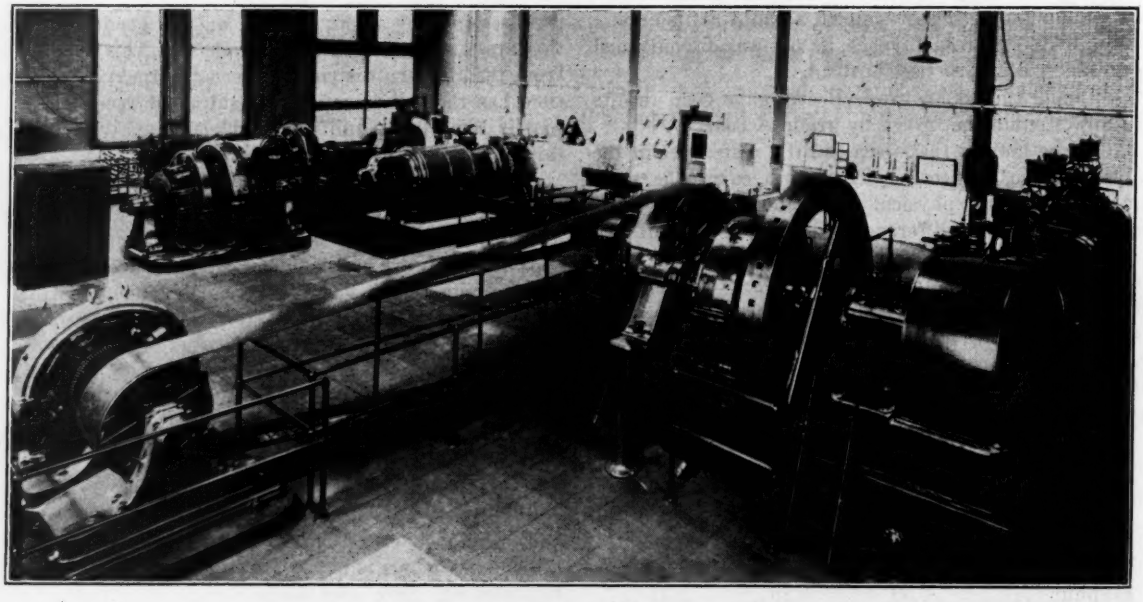


FIG. 1. GENERAL ARRANGEMENT OF ENGINES AND TURBINES

compared favorably with a geared d.c. generator. The former also provided for the use of outside power if future conditions demanded, or it could care for a gradual change to alternating current in the factory. The plant is on the Allegheny River, near coal, and in the vicinity of a proposed chain of hydro-electric developments, one of which is in operation. A 1580-kv.a., mixed pressure-extraction, condensing turbo-generator with a 250-v., 1500-kw., synchronous converter was selected as meeting present conditions and as being most adaptable to the several future possibilities. The arrangement provides for future switching equipment between the alternator and converter. Alternating current is now purchased for a 4500-lb. steel furnace and a 500-lb. brass furnace, as their loads are deemed too erratic for a small system. The turbine manufacturer has, however, guaranteed the new generator to handle the furnace loads in an emergency.

Formerly the plant was heated with high-pressure steam in direct radiators, and also in 18 blast heaters making a total equivalent of 137,400 sq. ft. of direct radiation. Seventy per cent of this total has been connected to the exhaust mains. A new wet vacuum pump provides for a vacuum heating system with its attendant mild weather economy. A part of the returns from the high-pressure heaters was formerly lost due to flashing at the receiving tank. The calculated weight of flashed condensate, based on measured temperatures of the returns from the high-pressure heaters, was 15 per cent. As the receiving tank is outside, the vapor from it was unsightly especially on cold windy days. Figure 7 shows a simple, but effective flash pot made to fit the receiving tank.

The extraction device on the turbine can be set to hold automatically any pressure from 0 to 10 lb. gage in the exhaust main. If the available exhaust raises this pressure a small amount the surplus is admitted to the turbine. A slight drop in pressure causes extraction. The recording exhaust pressure gage shows that

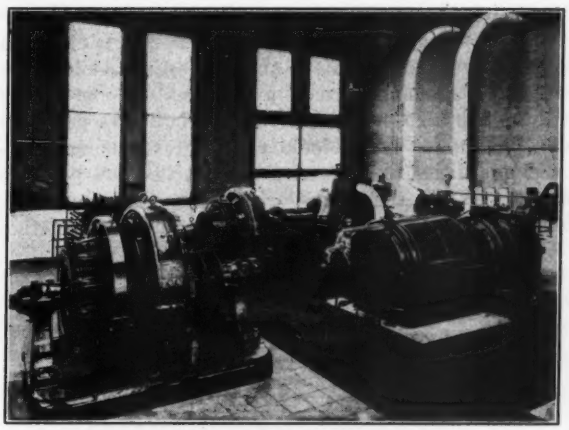
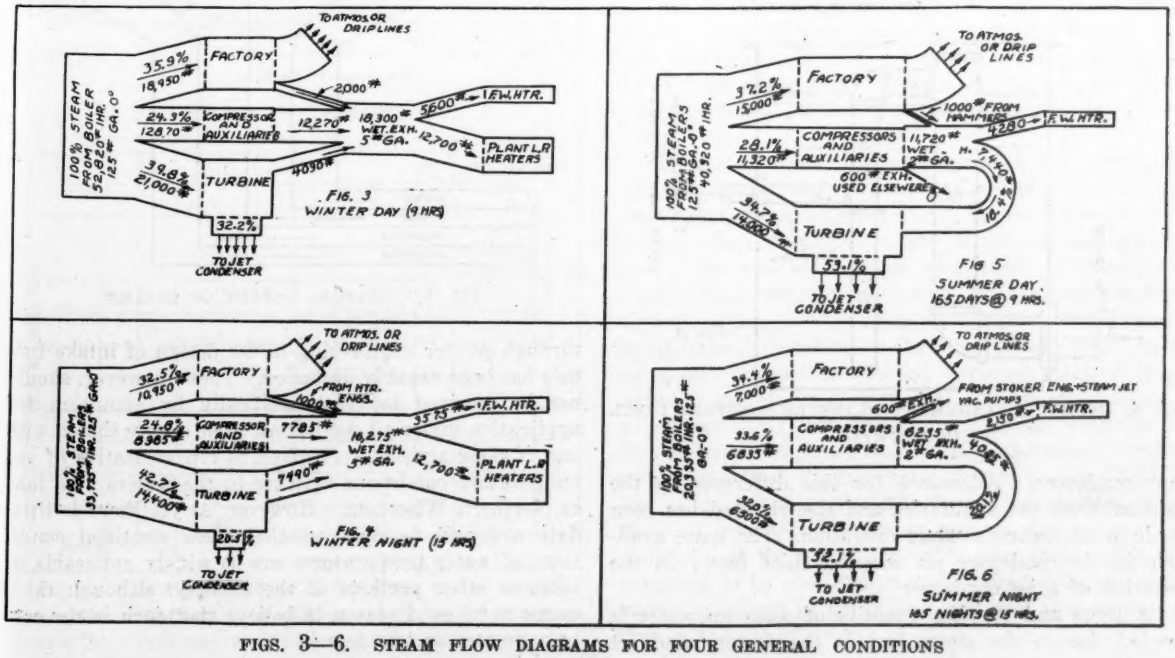


FIG. 2. NEW MIXED PRESSURE TURBINE AND CONVERTER IN FOREGROUND. 1200-KW. GEARED TURBO-GENERATOR IN BACKGROUND

pressure fluctuations are well within the guaranteed limits. During periods when no extracted steam is need the grid valve is set to hold 2 lb. gage, which is the pressure deemed most suitable for the existing feed water heater, notwithstanding an improvement in the efficiency and capacity of the auxiliaries with a lower pressure. The auxiliaries have worked satisfactorily against a 10-lb. back pressure during trial, but a 5 lb. gage is believed to be the maximum pressure needed for heating. High-pressure steam may supply the heating system through a balanced reducing valve in case the new turbine is at standby. Naturally the new machine is used in severe weather when possible.

Approximate hourly steam flow charts for the four general conditions are shown in Figs. 3 to 6, with the new outfit running. More high-pressure plant heaters are expected to be changed over to the exhaust line before another winter. The live steam used by the factory is based on recording Bailey steam flow meter readings.



FIGS. 3—6. STEAM FLOW DIAGRAMS FOR FOUR GENERAL CONDITIONS

Steam for the auxiliaries was calculated for each machine by using the average weekly speed taken with Veeder revolution counters and the estimated load together with manufacturers' guarantees. Steam to the turbine has been estimated from the builder's performance curves for the metered electric load, using calculated quantities of extraction or admitted low-pressure steam. While the figures given are estimates, when totaled they closely agree with the annual production

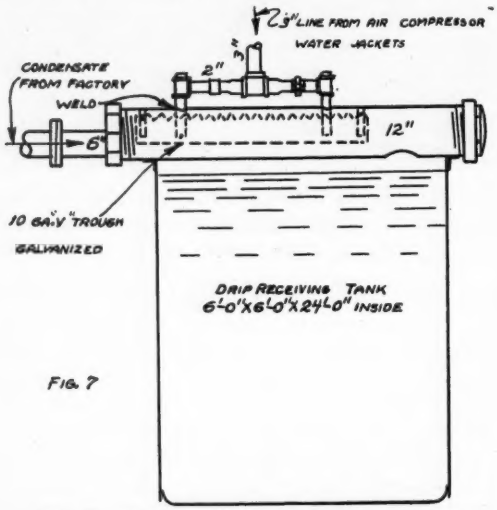


FIG. 7. FLASH POT AND RECEIVING TANK

of steam based on tested boiler room efficiency under normal operating conditions and the coal burned. The new installation was made in the fall of 1925, so no summer records have been taken. The new summer conditions should be little changed as the older turbine, four years old, is a mixed-pressure machine which uses plant exhaust in its lower stages. The old condenser pump is steam turbine driven while a motor drives the

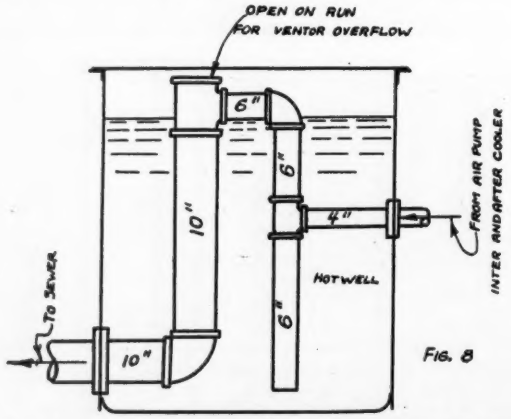


FIG. 8. PIPING ARRANGEMENT TO INSURE CONSTANT LEVEL IN HOTWELL

new condenser. Allowance for this difference in the exhaust from the auxiliaries and electric load has been made in estimating summer operation. The space available in the condenser pit was the chief factor in the selection of a jet condenser.

A large and varying quantity of make-up water is needed due to the steam lost in the factory and jet condenser. To insure a constant water level in the hotwell and to use warmed water for make-up the simple piping arrangement shown in Fig. 8 was devised. Warm water is taken from the condenser discharge line, passed through the inter and after cooler of the radojet vacuum pump, and then is tied into the hotwell overflow pipe as shown. It is evident from Fig. 8 that the hotwell is overflowed from the bottom and that the steady flow from the 4-in. make-up line will be either into the well or up into the overflow to waste, depending on the water level in the hotwell. The receiving tank, referred to in connection with Fig. 5, is at the same elevation as the hotwell and furnishes most of the return for boiler feed. The steam jet air pumps of the new machine are operated at boiler pressure without reducing valves. The older machine has a Le Blanc centrifugal air pump. Make-up water is supplied through a float valve from the mill service system when the older condenser is in use.

Circulating Water Intakes on Inland Rivers

IN THE ABSENCE OF SPECIFIC DATA, STRATIFICATION OF WATER IN RIVERS MUST NOT BE ASSUMED. BY CHARLES E. COLBORN

THERE HAVE BEEN several articles published recently on intake structure design in which the considerable potential gain in the built-in performance of the power plant and other condensing equipments

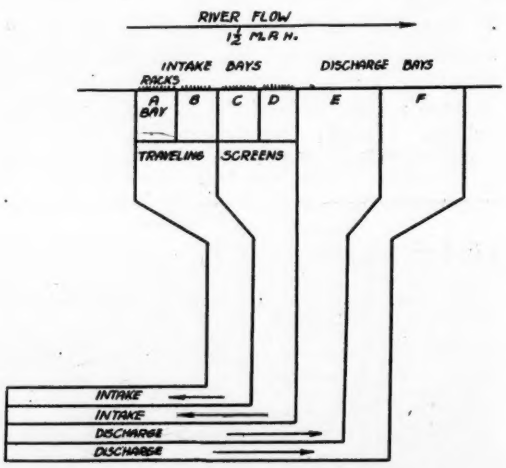


FIG. 1. GENERAL LAYOUT OF INTAKE

through proper engineering in the design of intake tunnels has been capably discussed. These, however, should not be received too enthusiastically by engineers for application under all conditions. The curves shown with one of these articles were given as representative of the temperature conditions existing in the waters of a lake in Northern Wisconsin. However, as yet there is little data available to show whether these stratified conditions of water temperatures are so widely noticeable in lakes in other portions of the country, although there seems to be good reason to believe that such is the case to a greater or less degree.

Even with a liberal estimate of the percentage of power generating installations in this country which are in a position to benefit from this stratification of lake waters would be considerably under one per cent, the larger number being located on some sort of inland stream. In such cases the stratification effect is not so pronounced, nor are conditions such that it would be possible to take advantage of what amount there is.

A short time ago the author had occasion to make an extensive survey of the river temperature conditions at the intake tunnel entrances of a plant located in the north central part of the country and feels that the data secured there is of value.

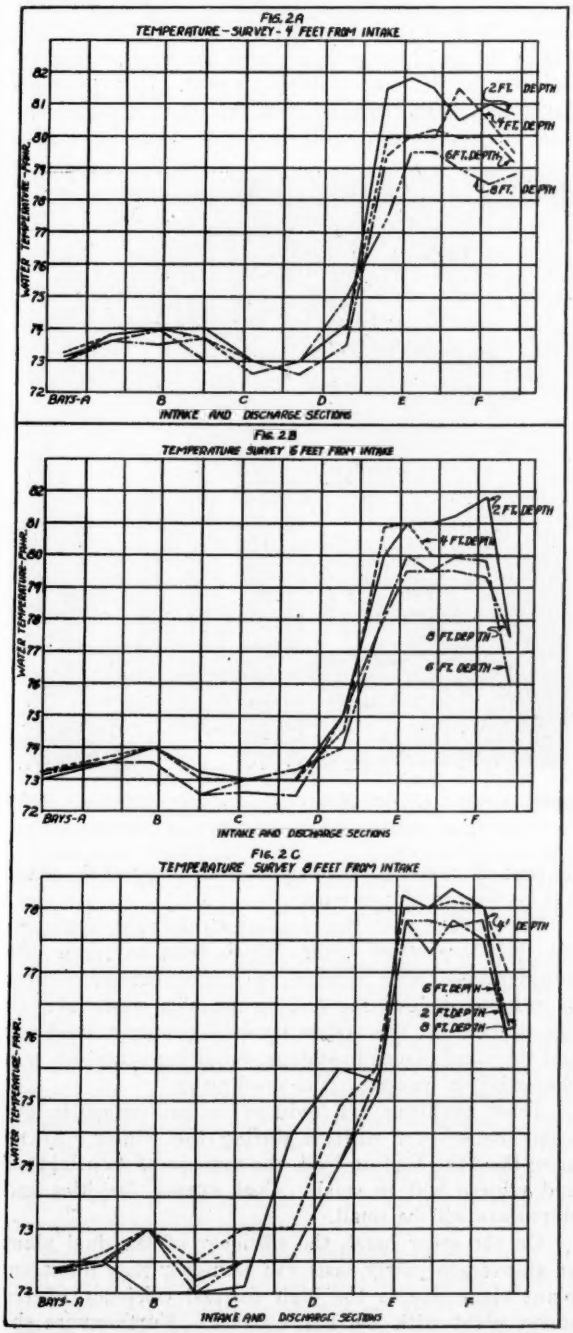


FIG. 2A. TEMPERATURE SURVEY, 4 FT. FROM INTAKE
FIG. 2B. TEMPERATURE SURVEY, 6 FT. FROM INTAKE
FIG. 2C. TEMPERATURE SURVEY, 8 FT. FROM INTAKE

In this particular instance the intake and discharge tunnels lay side by side, as shown in the general layout, Fig. 1. It was thought that there might be some recirculation of warm water and a survey to check this was made. Temperatures were taken at three points and levels and data as shown in the curves of Figs. 2a, 2b and 2c were obtained. As is shown, there was very little recirculation, certainly not sufficient to justify the use of diversion walls between the intake and discharge tunnel. Also, the temperature at the maximum depth, six feet, which was within two feet of the river bottom, was very close to the average of the other three depths.

This particular river flows at the rate of about a mile and a half per hour at this location, the station being located on the inside of a bend where the river bed is about 1000 ft. wide and of uniform depth. The nearest mills on the plant side of the river discharge into it two miles above the plant, and on the other side there are none within a mile of the station. The upper mills are the first on this river in over 75 miles and the water at this point is not affected by eddies. In short, conditions for many miles above the station are conducive to stratified flows. As is shown, however, stratification was non-existent here. Hence any attempts at design of intake to take advantage of the lower waters would be barren of benefit.

In another instance, a company operating a large station was having considerable trouble with trash. Being also on the inside of a bend, and located below several other industries, an attempt was made to utilize the cooler and cleaner (?) bottom strata of the river by dredging a channel across the river to the outer portion of the bend. The result was an increase in the trash nuisance of about 150 per cent. Evidently the bottom strata of flowing waters may be carrying a large load of trash and silt which would make them well worth avoiding.

Conditions confronting various plants are so different, however, that it requires a large amount of data to assist in forming any opinion of any value on such cases. The experiences of others on stream measurements would be of great value and interest in the considering of this subject which is one worthy of careful thought.

IN THE OPINION of the Compressed Air Society, the increasing tendency toward motor-drive has been the most determining single factor in the development of the present day compressor. The almost prohibitive first cost of the slow speed, direct-connected motor used with the old type compressors greatly handicapped the development of the motor-driven unit. This led compressor manufacturers to develop the light automatic air valves of today, permitting greatly increased rotative speeds and the use of direct-connected synchronous motors at a comparatively low first cost. This development was also of benefit to the steam-driven compressor. Previous to the advent of the automatic air valves, the speeds of the steam-driven compressors were considerably below those of corresponding steam engines due to speed restrictions of the air valves. The new valves allow the machines to be operated at speeds limited by the steam valves, resulting in lower first cost and increased economy in the use of steam.

Diesel Makes Ideal Steam Plant Standby

EVEN WITH HEATING LOAD THERMAL EFFICIENCY WILL OFTEN OUTWEIGH OTHER DISADVANTAGES. BY C. C. HERMANN

DUAL POWER UNITS form the basis for a certain percentage of public confidence in public utility companies. The initial cost, standby charges and obsolescent possibilities are overlooked, forgotten in the anticipation of continued and uninterrupted service. Public-owned plants constitute an element of pride which dictates that such plants shall be exemplary of the public ambition and expectation of community growth. They are, therefore, equipped with the most efficient units not infrequently several times larger than immediately necessary, their oversize defeating the possibility of efficient operation in order to take care of community expansion.

In electric generating plants duplicate generating units appear necessary to insure continued service. Manufacturers will not risk a shutdown, city streets and homes must have the assurance of light at the snap of a switch, electric cars must move at all costs, but a generator cannot operate indefinitely without repairs. Accidents, too, may happen, rendering the generator useless.

Standby units are common. Their installation and maintenance have been a matter of necessity for years, an accepted responsibility of the public utility company and the municipally-owned plant. Dual power plants have been in existence for a number of years in scattered localities. Their success has been watched carefully and guarded jealously, advertised widely by the manufacturers and talked loudly by community interests. At the present time, however, there appears to be a new trend, the substitution of an entirely different power generating unit in the form of the Diesel engine.

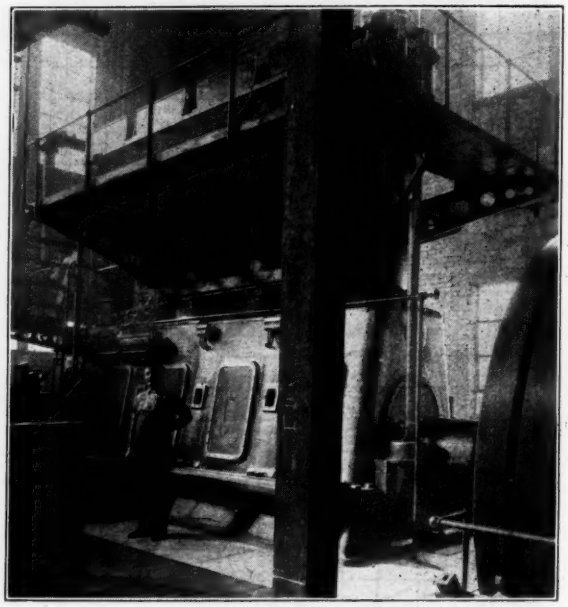
DIESELS ELIMINATE MUCH DETAIL

The Diesel does not depend upon a boiler plant. There are no grates to burn out, no boiler setting to repair, and when stopped no fuel charge; no boilers to wash down, no water to treat, compounds to purchase, fires to bank, no long drawn-out preparation to place the plant in operation, no waiting to get up steam, no smoke stacks to rust out, paint to replace. Coal storage, coal analysis and ashes worries are eliminated. Coverage for huge boilers is unnecessary and the list of power plant employes shortened considerably.

These are a few of the factors which influence the installation of the Diesel as the parallel unit. There is a definite field for the Diesel and a corresponding definite field for the large steam and hydro-electric plants. In the Northern states the necessity of steam for heating complicates matters, steam being most advantageous in the colder months, the Diesel in the summer months. There is, of course, the real deciding factor, the matter of cost, to be considered as well.

Attention is called to the photograph which shows the 750-hp. McIntosh & Seymour Diesel in the municipal plant of Cedar Falls, Iowa. This engine drives a 525-kv.a., 3-phase, 60-cycle generator. The unit is operated in connection with a steam plant and has been in use for 2 yr. During the summer months when no steam for heating is required the Diesel operates 24 hr. a day but in the winter months this is cut down to the equivalent of 10 hr. a day. The steam plant takes care of the balance of the load during the winter months. 32/36 gravity gas oil is used producing from 8½ to 10½ kw-hr. of electricity per gallon of fuel at a cost, for fuel and lubricating oil, of approximately $0.007 per kw-hr.

Using exhaust steam for heating, the thermal efficiency of the plant may be as high as 75 per cent, but remove the heating load and the thermal efficiency will drop as low as 12 per cent, drawing the average thermal efficiency for the year to 43½ per cent. It is quite apparent that with the dual installation, eliminating the boiler plant and steam units during the summer months,



DIESEL ENGINE IN CEDAR FALLS, IA., PLANT USED AS MAIN UNIT IN SUMMER AND STANDBY IN WINTER

the over-all yearly average thermal efficiency of the plant will be close to 50 per cent.

On the face of it, the idea has its desirable features; but there are other factors which must be taken into consideration. For instance, the steam plant crew must be reduced each spring and re-employed each fall. Is this practical? The boilers must be properly dried out and the plant placed in storage, requiring some care and close study to preserve it in good order.

These problems are reduced in proportion to the boiler horsepower utilized during the winter. If no more than the heating load, the number of men laid off and rehired will be small. Coal storage facilities and shipments will be small.

On the other hand, the efficiency of the dual plant on an average yearly basis will be higher than the steam plant alone due to the high thermal efficiency of the steam plant with the heating load. Furthermore the labor charge per unit of power output will be lower, due to the absence of firemen, ash haulers and other help when operating the Diesel.

Diesel Exhaust Gives Valuable Information

DIESEL ENGINE performance can be judged closely by the temperature and CO_2 content of the exhaust gases. Capable engineers are guided by the scent and appearance of these gases much as a good fireman is guided by the appearance of his fire. Sensitive instruments, however, remove the element of doubt, or personal judgment, and indicate the combustion process accurately. Recording instruments may be used to give a permanent operating record and show, by progressive stages, when and where adjustments and repairs become advisable.

Discussing tests of a horizontal, two cylinder, four cycle, belt drive, Koerting solid injection engine with a rating of 200 b.hp. at 180 r.p.m., Waermewirtschaft in the March issue, draws some interesting conclusions regarding the influence of load, speed, fuel, cooling water temperature and irregularities in engine operation upon the temperature and CO_2 content of the exhaust. Both

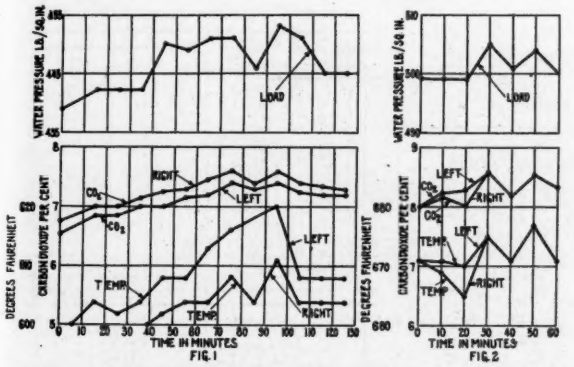


FIG. 1. TEMPERATURE AND CO_2 RECORDS OF TEST MADE BEFORE REPAIRS

FIG. 2. TEST RESULTS AFTER VALVE WAS REPAIRED

the temperature and CO_2 content increase with the load and also with the cooling water temperature. Leaky exhaust valves will raise the CO_2 content and lower the temperature, irregular fuel pump operation causes flustrations of the CO_2 content and exhaust temperature, while the relative values of these two, for good combustion, will vary with the fuel used.

Figures 1 and 2 are the results of two particular tests using 1/5 ignition and 4/5 tar oil. Cooling water was kept constant, at from 122 to 124 deg. F., with readings taken every 10 min. Gas samples drawn from the exhaust pipes through small copper tubes were analyzed by a recording CO_2 instrument. Temperature measurements were taken by copper-constantan thermocouples extending about 6 in. into the exhaust pipe and protected by an iron tube. Both instruments were arranged so that the exhaust of the cylinders could be measured singly or together.

Increases in the CO_2 and temperature with load are shown on both tests. During the two hour test, Fig. 1, the right-hand exhaust valve was not tight and the effect is clearly indicated by the difference between the CO_2 and temperature measurements of the two cylinders. Figure 2, the result of a test made on the same engine immediately after the valve was repaired, indicates normal operation of both cylinders.

Turbine Designed for Different Operating Conditions

A STEAM TURBINE which can be used with relatively low steam pressure and temperature in a present station, but which with slight changes can be used with steam of high pressure and temperature when the station is modernized, is to be installed by the Trinidad Electric Transmission, Railway & Gas Co. of Trinidad, Colo., with plants at Trinidad and Walsenburg.

In the Trinidad plant there is a 5000-kw. steam turbine-generator set; the Walsenburg plant is at present of smaller capacity. The power demand made it necessary to add to the equipment of the Walsenburg station, which is an old plant with low steam pressure and superheat. The company is looking forward to the day when it will put in new boilers, raising the steam pressure and temperature to a point which will give the economy of a modern plant. Inquiry was therefore made for a machine which could be used at present on 165 lb. steam pressure and 100 deg. superheat, and which with minimum modification can at a later date be used on a pressure of 350 lb. or more and a total steam temperature of 700 deg. F.

A 6000-kw. steam turbine meeting these specifications was designed by the engineers at the Lynn works of the General Electric Co., and is now being built there. The unit is laid out with all high pressure parts suitable for the maximum steam temperature and pressure, and provision is made for eventually mounting 14 wheels; but as first installed for the lower steam pressure it will have nine wheels, and the first-stage nozzle and bucket will be suitable for the lower pressure.

When the plant is rebuilt for 350 lb. steam pressure, it will merely be necessary to place the extra five wheels and high pressure nozzles in the turbine.

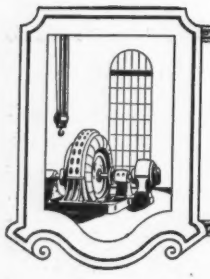
Nickel-Chromium Cast Iron

ADDITION of nickel and chromium to cast iron is a recent alloy development which is proving of great use. In such parts as flange couplings addition of 1.5 to 2.5 per cent nickel to iron having high silicon content has permitted lowering the silicon 50 points below normal, giving a strong dense casting, free from internal shrinkage and easy to machine.

By using 1.5 per cent nickel and 0.5 per cent chromium, cylinders cast vertical were made of uniform hardness from base to dome, yet machined as easily as softer plain iron.

For cast resistance grids, adding 5 per cent nickel has been found to increase electrical resistance and improve toughness as well as eliminating the tendency toward formation of hard or chilled white iron in these thin section castings.

Other parts, such as gears, pistons, piston rings, valve and pump cylinders can be improved in strength, uniformity and workability by this nickel and chromium alloy, which involves no difficulty in the making of castings. Amount of the alloy depends on the conditions to be met and may be added in the cupola, furnace or ladle as most convenient, with dependable results, whichever method is used. Details are given in bulletin 201 issued by the International Nickel Co., 67 Wall St., New York, N. Y.



ELECTRICAL MACHINERY FOR LIGHT AND POWER

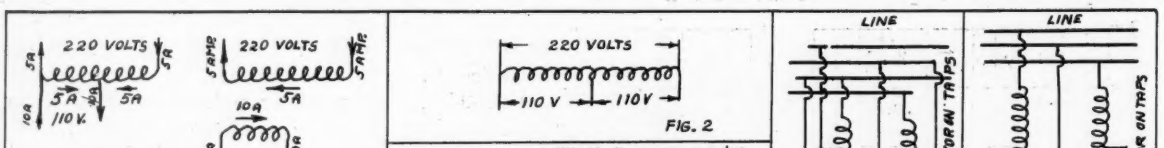
Principles of Transformer Connections---VII*

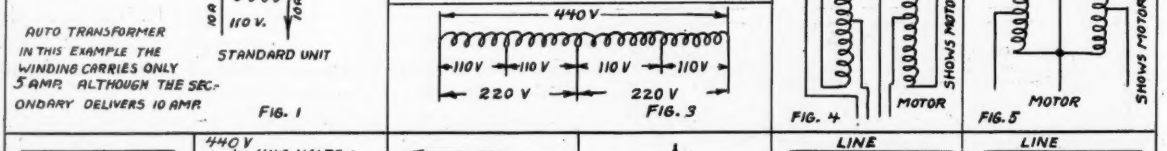
AUTO-TRANSFORMERS AND BALANCE COILS. BOOSTER CONNECTIONS. SPECIAL CONNECTIONS OF STANDARD TRANSFORMERS. BY V. E. JOHNSON

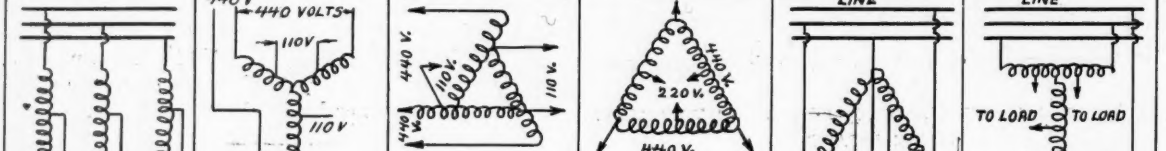
AUTO-TRANSFORMERS, balance coils and "compensators" may be grouped in the same class of apparatus and are distinguished from the ordinary transformers by differences in connection. In this type of transformer, the primary and secondary are electrically connected, and certain portions of the winding may serve as both primary and secondary. Figure 1 shows the relation between these two types, and gives a set of values that indicate why there is a saving of active material. In the part of the winding which carries both primary and secondary currents, the amperes flowing are arithmetically equal to the difference between them.

It will be seen from this that as the auto-transformer approaches a one-to-one ratio, more of the winding will serve as a common conductor for both primary and secondary currents, so that the economy in the use of copper increases.

On three-wire systems, the units required have a ratio of two to one, and are connected as shown in Fig. 2. In this case, the rating should be great enough to take care of such unbalances as may occur. Obviously, the extreme condition would be the one in which







FIGS. 1-13. METHODS OF CONNECTING AUTO-TRANSFORMERS AND BALANCE COILS ARRANGED IN ONE CASE (FIG. 14) TO ADD TO, AND IN THE OTHER (FIG. 15) TO BUCK THE SECONDARY VOLTAGE FIGS. 14-15. BOOSTER CONNECTIONS

*Previous articles of this series appeared in the following issues of Power Plant Engineering: Sept. 15, 1925; Nov. 1, 1925; Dec. 1, 1925; Feb. 15, 1926; April 15, 1926, and June 15, 1926.

all the load is on one side of the system, but ordinarily it is possible to operate within a 25 per cent unbalance, and this value is frequently used as the basis for making the selection.

An auto-transformer may be subdivided into any number of sections to take care of various types of multivoltage systems, the commercial limit being the five-wire type, as in Fig. 3. This plan may be used for industrial lighting, but it introduces many undesirable features, and should in general be avoided. It is adapted to special variable voltage applications.

Motor Starting Service

Perhaps, the most common application of auto-transformers is the starting of squirrel cage induction motors. In this case it is much preferable to resistance type starters, in that it reduces the amount of current taken from the line for a given motor rating. For example, assume that a 440-v. motor requires 100 amp. starting current for a certain assumed load condition. With a resistance type of starter the line would have to supply this amount, but with a two-to-one auto starter the current taken would be only 50 amp. This is based on the assumption that this ratio would be sufficient to pass 100 amp. through the motor.

Figure 4 shows a motor starting auto-transformer having two coils, connected on a two-phase system. Figure 5 shows the same starter on a three-phase line. Figure 6 shows a three-coil starting auto-transformer (which really consists of three single-phase units) on a three-phase motor. In any one of these schemes, the voltage required for starting is obtained by a switch which is arranged to energize the auto transformer and simultaneously supply reduced voltage to the motor terminals. In the running position, the motor is directly across the line, with the auto coils open circuited. The amount of starting current can be varied by means of convenient taps.

General Applications and Connections

On three-phase systems, a number of connections are possible. Figure 7 shows a star-star connection, Fig. 8 a star-delta, and Fig. 9 a delta-delta arrangement. The units may be either single or three-phase, and the underlying principles applying to the selection of a given method of connection are essentially those of the two winding transformers.

The increasing tendency for groups of central stations to combine into large operating systems, has necessitated the interconnection of transmission lines of different voltages. It is common to find a tie between 33,000 and 66,000, between 66,000 and 132,000, and between 44,000 and 66,000-v. lines. Each of these ties requires a transformation, and auto-transformers have had fairly wide application in solving the problem, due to the economy of material, and saving in cost. Such installations should be carefully analyzed with a view of determining the hazards that might be involved in each particular case. For example, a 33,000 to 66,000-v. setting might, under abnormal conditions, impose the higher voltage on the apparatus connected to the lower voltage lines, and so do considerable damage, both to machinery and to transmission line.

In Fig. 10 is shown two auto-transformers connected in open delta. Figure 11 shows a T connection. Either of these is suitable for use in three-phase service.

For three phase-two phase transformation, a Scott connection as illustrated in Fig. 12 may be used. In the absence of transformers with the 86.6 per cent taps, an unsymmetrical connection as in Fig. 12 will give satisfactory operation when power is to be supplied to ordinary industrial loads, but it can not be used between synchronous machines because of the unbalanced voltage conditions. Figure 13 shows another method of phase transformation, using a three-phase auto, or three single phase units. There is no particular advantage in the latter scheme, for the Scott will accomplish the same result in a simpler manner.

In general, any two winding transformer can be used as an auto-tranformer, by using one of its windings, and leaving the other open circuited. The possible voltage combinations depend on the coil arrangement and taps.

"Booster" Connections

It is sometimes desirable to add to the voltage of a feeder a small percentage, in order to compensate for line drop, or to permit apparatus of slightly "off standard" ratings to operate properly. At other times the voltage must be reduced a similar amount for corresponding reasons.

Figure 14 shows a standard transformer installed as a booster while Fig. 15 hows the same unit connected to buck. The values indicated are typical. In either case the operation is the same, the secondary voltage of the transformer being added to the line voltage algebraically.

In making an installation of this kind there are a number of precautions to be observed. The full line voltage is impressed upon the low voltage winding, with the consequent strains on the insulation to ground. It would therefore be impossible to ground the case of a standard transformer without incurring grave risk of a failure, due to the potential stresses. On the other hand, if the tank is left ungrounded, as would be the case with pole mounting, a considerable personal hazard exists. The lineman might easily form the link between the tank and the ground, this being a particularly grave possibility because of the fact that ordinarily a tank can be touched without any danger. A pole mounted booster installation can not very well be guarded but the least that can be done is paint the tank red, and to have warning markings on the pole. This is, however, at best, a dangerous condition.

On installations in substations or enclosures on the ground, the tank is usually mounted on a marble slab or on an insulating platform which makes its dangerous features more noticeable; furthermore, suitable guards can readily be installed.

It is best practice to purchase transformers with special secondary insulation, so that the tank may be grounded, thus eliminating the personal hazard. This does not add very much to the cost and is in line with the modern tendency toward "Safety First." In order to avoid mixing these special units with the ordinary distribution transformers, it is well to have them given distinctive markings immediately upon arrival.

Connection and disconnection of a booster unit requires special precautions. If the low winding is carry-

ing current and the primary side should become disconnected, the condition of an open circuited current transformer would result. The voltage on the primary terminals would rise to an exceedingly high value which would in all likelihood cause a failure. If failure did not result from an insulation break down, it would certainly follow in a comparatively short time due to the high flux density in the iron, and the resultant high temperature. Fuses must therefore not be used in the primary and if cut-outs are used for convenience in making connections, they must be "fused up" with heavy wire which will not blow under any except extreme short circuit conditions which would in any event destroy the unit.

It is almost impossible to install or remove a booster transformer without interrupting the supply circuit, at

FIGS. 16-22. MORE BOOSTER CONNECTIONS USED IN PRACTICE

least momentarily. If the primary be opened first, an extremely high voltage will result, while if the secondary be shorted out first, a heavy current will flow, and with the practically unfused installation, this would have to be interrupted by pulling the plug in the cutout which would be rather hazardous. If the line can not be killed, even for a moment, it is possible to make the required change by means of special devices. If the connection or disconnection is to take place only at rare intervals these special means may consist of reactors shunted across the secondary for a moment, and serving as the intermediate step between full operation and complete isolation. For example, in cutting the booster out of service, the sequence would be as follows:

a. Connection reactor in shunt with the secondary coils.

b. Pull the primary cutout or otherwise disconnect the primary.

c. Short circuit the reactor and secondary coils.

d. Disconnect them from the circuit.

Another method, which would be suitable for comparatively small units, employs no reactor, but uses instead a temporary fuse block, shunted around the regular cutout. In this case, the sequence would be as follows:

a. Install a fused cutout in parallel with the regular one, using fuse wire of sufficient capacity to carry safely the existing load, but small enough to blow under short circuit without too much of a disturbance, and then pull the regular plug.

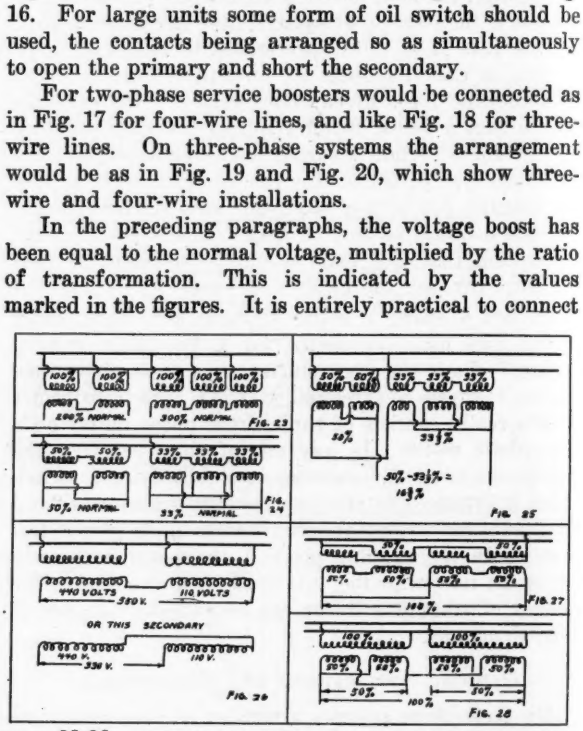
b. Short circuit the secondary winding, using a switch or safety fuse block with heavy wire, or other means that will involve no personal hazard to the lineman. This operation will cause the primary fuse in the temporary block to blow.

c. Disconnect the primary from the line entirely, short out the secondary with a piece of wire, and remove the temporary fuse blocks.

Either of the foregoing methods is cumbersome and necessitates extreme precautions to avoid personal injury to the lineman. If the service conditions are such as to require periodic boosting or bucking, some special switching apparatus should be installed. This could consist of ordinary arc lamp cutouts which close when the bayonet is removed, the connection being that in Fig. 16. For large units some form of oil switch should be used, the contacts being arranged so as simultaneously to open the primary and short the secondary.

For two-phase service boosters would be connected as in Fig. 17 for four-wire lines, and like Fig. 18 for three-wire lines. On three-phase systems the arrangement would be as in Fig. 19 and Fig. 20, which show three-wire and four-wire installations.

In the preceding paragraphs, the voltage boost has been equal to the normal voltage, multiplied by the ratio of transformation. This is indicated by the values marked in the figures. It is entirely practical to connect



FIGS. 23-28. SPECIAL CONNECTIONS OF STANDARD TRANSFORMERS

the primary to the "boosted" side of the transformer, as shown in Fig. 21, thus obtaining a still higher voltage on the feeder. Similarly, bucking transformers may have their primaries connected to the "bucked" side, thus reducing the value of the secondary voltage and resulting as before in a somewhat higher voltage on the feeder. This is shown in Fig. 22.

It is evident that a transformer having a series parallel secondary, such as 115-230, can be connected so as to give four different boosting and an equal number of bucking values. If, in addition, the primary has taps, a great number of combinations can be obtained. On the other hand, change from one connection to another can be accomplished only with considerable difficulty, so that other means must be used to maintain satisfactory regulation on lines having varying load conditions. For such applications a feeder regulator should be used.*

Unusual or emergency conditions frequently necessitate the use of standard transformers to obtain odd

*An excellent article on the subject of feeder regulators appeared on p. 797, July 15, 1926 issue.

voltages, and the paralleling of unlike units to take care of unexpected loads. In making these special connections efficiency and regulation will naturally suffer, the purpose being to maintain service.

Within reasonable limits transformers may be applied to lines having lower than rated voltages. For example, a 2300—230-v. unit may be conected to an 1150-v. primary to obtain 115-v. secondary. The converse is not true, for a comparatively small increase in the applied voltage, above the rating, will result in serious heating. A 25-cycle transformer may be used on 60 cycles or on 133 cycles, but a unit designed for a given frequency can not operate at a lower frequency. For example, a 60-cycle transformer can not be used on a 25-cycle circuit. Its use on intermediate frequencies is limited by and varies with the design, and if such operation is necessary the temperatures must be watched to see that they do not reach dangerous values.

In Fig. 23 is shown a method of obtaining secondary voltages higher than normal, using two or more units with primaries in parallel. The values indicated are typical. The ratio obtained would also apply on three-phase circuits with delta-delta or star-star connection. If the primary were in star and the secondary in delta, the ratio would be multiplied by 1.73. If the primary were in delta, with the secondary in star, the ratio would be divided by 1.73. In the former case the primary voltage could not exceed 1.73 times the transformer primary rating, while in the second case, it could not exceed the normal rating. The great number of units required on polyphase lines would limit the application of this method, but in emergency it would be permissible.

To obtain secondary voltages lower than normal, using two or more units with the primaries in series the connection shown in Fig. 24 is used. Groups so arranged, could be connected in star-star, delta-delta, star-delta, or delta-star, with corresponding changes in the arithmetical value of the ratio of transformation, and in the permissible line potentials.

Figure 25 shows a method of obtaining an odd voltage by bucking two groups of transformers, so as to obtain a terminal value equal to the difference between the two. By reversing the connection of either group the terminal voltage would be equal to the sum of the individual values.

In Fig. 26 we have two transformers of different ratio, connected with primaries in parallel, and secondaries in series, thus adding the terminal voltages. Reversing either of the units would give a voltage equal to their difference, as indicated in the figure. It would also be possible to feed this combination from the low side, thus supplying a 2300-v. line from a 550 or a 330-v. source.

The number of possible combinations is practically unlimited, and, given a sufficient number of transformers, emergency installations can be made to meet almost any voltage condition.

In Fig. 27 is shown a method of forcing two transformers of equal ratio but different impedances to operate in parallel. This is applicable only when the primary is in series parallel. The primaries are in parallel, the same current passes through both units, and therefore the load is divided equally between the two. Figure 28 shows a somewhat analogous arrangement, in which the secondaries are in series to force division of load.

Systems for Cooling Electric Generators

AMONG THE VARIOUS SYSTEMS DEVELOPED AND SUGGESTED, THE PROPOSED USE OF HYDROGEN AS A COOLING MEDIUM IS MOST NOVEL

IF IT WERE possible to build electric generators that were one hundred per cent efficient this article would never have been written and the author would have had to forego the opportunity of immortalizing himself by the production of so refreshing a contribution to generator literature. Generators are not one hundred per cent efficient, however, and since the author is entitled to a living (there may be considerable disagreement on this point) perhaps it is just as well that there are losses in machines which manifest themselves as heat, for it is the question of most effectively removing this heat that furnished the inspiration for this article.

"Way back when" automobiles were steered with tillers and when electric generators were still called dynamos, the question of heat removal was relatively unimportant. The machines were of open construction and the output of electrical energy per pound of material was small. There was always sufficient radiating surface to dissipate the comparatively small amount of heat generated without resorting to special methods of cooling.

With the development of the steam turbine and the adoption of higher speeds, as well as the use of better grades of material, the capacity of electric generators and the output per pound of material increased greatly. In spite of the improved efficiencies of these machines, the amount of heat produced was so great that the natural radiation was no longer sufficient to maintain the unit at a safe temperature and special methods of ventilation became necessary.

Today, the large generators in use are vitally dependent upon forced methods of ventilation, in fact, if an interruption occurs in the supply of cool air to a modern machine, it can operate for only a few minutes without overheating.

METHODS OF COOLING

Two general methods of cooling have been developed, one, which until a few years ago was used exclusively, known as the direct cooling method, and the other, now coming into vogue, the indirect, or closed system method of cooling. With the first method mentioned, the heat is carried off by filtered or washed air which, once used, is discharged to the atmosphere or, if the heat in it is worth reclaiming, sent to the boiler room and burned. In the indirect system, the heat is carried away by water, air being used merely as a transfer medium between the generator and the cooling water. The ventilating system in this case is a closed circuit, the air being used over and over, but cooled by water after each passage through the system.

In order to discuss the relative merits of these two methods let us first consider, briefly, the amount of air required to properly cool modern generators and the effect of passing the required quantity of air through the machine.

Since the heat produced in an electric generator is a function of the losses, the amount of cooling air required to remove the heat from a particular machine is easily determined, provided the size and the efficiency of the machine is known.

From practical experience, it has been found that for machines ranging from 7500 to 30,000 kw. capacity the amount of air needed is from 3 to 2.25 cu. ft. per kw. while for units of from 1000 to 6000 kw. the air required varies from 5 to 3.5 cu. ft. per kw. These figures are based on sea level conditions; therefore for higher altitudes they may have to be increased.

Since the air requirements are dependent upon the

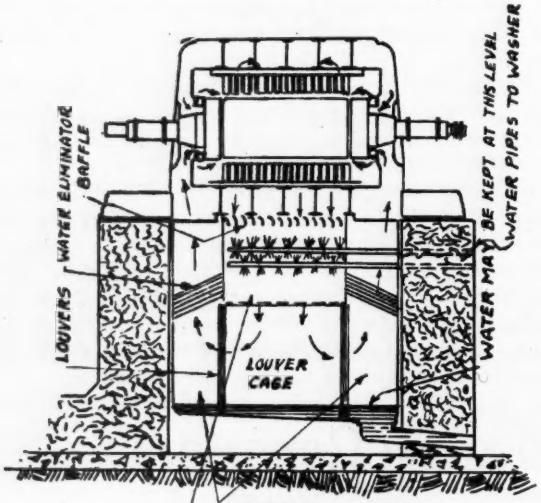


DIAGRAM ILLUSTRATING THE CLOSED CIRCUIT SYSTEM OF VENTILATION USING A SPRAY TYPE COOLER

generator losses, the number of cubic feet of air needed can, perhaps, best be expressed in terms of the kilowatt loss of the machine. In general, this is from 85 to 100 cu. ft. per min. per kilowatt loss.

A 20,000-kw. generator, therefore, with an efficiency of say, 97 per cent will require $0.03 \times 20{,}000 \times 90$ or 54,000 cu. ft. of air per min. This is a considerable amount of air. If we take the weight of air at 70 deg. F. as given in Kent at 0.07494 lb. per cu. ft., the total amount of air passing through this 20,000-kw. generator in a year, assuming continuous operation, is a trifle over a million tons!

A million tons of air! Imagine it. What effect will the passage of this enormous quantity of air have upon the generator? How much dirt does it carry and how much of this dirt will it deposit on the machine? What precautions must be taken?

Suppose we take our slide rule and figure it out. If the air contains one-tenth of one per cent dirt, and by dirt we mean soot, coal, coke, oil, salts, sand, etc., the total amount passing through the machine would be 1000 tons. If, to remove this dirt, a filter is installed which is 99 per cent efficient, there will still be 10 tons passing into the generator.

Naturally, there is no room in the average generator for 10 t. of dirt and only a small part of it will remain. However, if we assume that only one per cent of it remains, there will still be an accumulation of 200 lb. during the year.

This foreign matter may or may not, be detrimental to the life or operation of the generator but in any case, its presence is not to be desired. Oil, coal, coke and soot are inflammable, acids and salts may destroy insulation, sand is abrasive. Every effort must be made to keep this material out of the machine. This brings us to a consideration of filters.

Filters and Coolers

If the direct method of cooling is employed, it is obvious that the filter provided must have as high a dirt removal efficiency as possible. The air used in this system is drawn directly from outdoors and the atmosphere in the vicinity of the power plant, particularly in industrial districts, is usually heavily laden with dirt; hence the need for an effective filter. In the indirect system of cooling, the efficiency of the filter is less important since the air in the system is continually being reused and the amount of foreign matter carried is small. Nevertheless, unless the system is exceptionally tight and kept so, dust will leak in and a good filter is necessary.

Filters available may be grouped into three general classes; first, the type used most extensively in this country, the air washer which consists of water sprays for actually washing the impurities from the air; second, the cloth filter, used extensively in Europe, consisting of frames covered with cheese cloth; and third, the type in which copper tubes or blades, coated with an oily substance, catch the particles of dirt. The latter type has been introduced into this country only within recent years, but seems to give good satisfaction. When dirty, the sections are cleaned by dipping them in a soda solution and then recoating them by dipping in a bath of the adhesive fluid.

Coolers for cooling the air to the generators, too, can be grouped under three headings. The first type is simply a spray washer used as a cooler and differs in no way from the spray type filter referred to above. The second type, known as the film type, consists of a number of plates over which a thin film of water is continually flowing. The third now coming into extensive use is the surface cooler type. This cooler resembles the surface condenser and differs from the first two coolers described by the fact that no direct contact exists between the air and the cooling water.

Features of the Indirect System

Due to the limitations of air washers in removing dust and the fire hazard introduced with large volumes of air passing through the generator, the closed or indirect system of cooling in which the air and not the water is recirculated is gaining in popularity and many installations are being made. Another advantage of the closed system is the simplicity of the duct layout and its compactness. The duct work to connect the washer to the intake connections and the outlet of the generator with the open system, is often difficult to arrange but

with the closed system this difficulty is entirely avoided. The entire system, including the washer is usually installed inside the generator foundation as shown in the accompanying illustration. This arrangement has the advantage of using what might otherwise be waste space and at the same time leaves room for other apparatus outside of the foundation.

In an installation of this kind which is usually designed to fit particular conditions, the chamber as will be noted is ordinarily divided into three parts, the middle one acting as the downtake for the hot air from the generator and the outside ones acting as uptakes returning cool air to the end bells of the generator. The spray nozzles or whatever type of cooler is used, may be located at the top of the downtake chamber as shown or, if the spray nozzles are used, a second arrangement is to place them near the bottom of the downtake with the spray directed upwards. To prevent water from being carried up into the generator, eliminator plates are provided.

Fire Protection Related to Generator Cooling Systems

As indicated in the foregoing, the closed system of ventilation because of the limited amount of oxygen associated with it, has inherent fire protection features not obtained with the direct system. In fact with the direct system a fire hazard is introduced. With the closed system, in case of a fire, the oxygen is soon consumed, generating CO_2 and rendering the system incapable of supporting combustion.

In this connection, the use of mediums other than air have been suggested. By introducing into the system an inert gas such as CO_2, for instance, the danger of internal fires would be considerably reduced.

While, to our knowledge, no systems using an inert gas as a cooling medium have been installed, a number of installations have been made where CO_2 is injected into the cooling system under high pressure in case a fire breaks out. In this case air is the cooling medium, and the CO_2 is introduced automatically only when required for fire extinguishing purposes. A system of this type has recently been purchased by the Commonwealth Edison Co. for the protection of a 30,000-kw. generator at Fisk St. Station. Another installation has been made in the Wabash River Station.

Hydrogen as a Cooling Medium

From another quarter has come the proposal that hydrogen be used in the cooling system. Strange as this idea may seem because of the explosive nature of hydrogen when combined with oxygen, experiments along this line have been extremely encouraging.

The advantages claimed for hydrogen as a cooling medium for large high-speed electrical machinery are: Lower density, higher thermal conductivity, higher forced heat convection, practically no damage to insulation by corona and prevention of fire.

Tests in hydrogen have shown a windage loss of 10 per cent of that in air. The total losses of large capacity alternators of 1800 at 3600 r.p.m. amount to approximately 2½ per cent and the windage loss is one or more per cent of the rated capacity. By operating such a machine in hydrogen the windage loss is practically eliminated and results in about 1 per cent increase in efficiency.

Hydrogen has approximately seven times the heat conductivity of air or as high a thermal conductivity as ordinary insulating materials. When a machine is operated in air, any spaces in the insulation appreciably increase the thermal drop from the copper to the surface from which the heat is to be removed by air. With hydrogen in the machine the gas spaces are no longer harmful in this respect, because of the greater heat conductivity of the hydrogen.

As for the explosion hazard introduced by filling the generator cooling system with hydrogen, this is not nearly so great as might be expected, provided proper precautions are taken and suitable protective equipment installed. In fact tests have shown that even in case an explosion did occur, the results would not be serious, as it is not difficult to vent machines.

This proposed use of hydrogen was fully described in a paper by Messrs. Knowlton, Rice and Freiburghouse presented before the A. I. E. E. on Oct. 23, 1925. In this paper it was brought out that the temperature rise was about the same when the machine was filled with hydrogen and supplying 133 per cent load as when filled with air and carrying 100 per cent load.

Reclamation of Generator Losses

Aside from the economies to be gained by added generator capacity attained by forced ventilation, there is also possible the reclamation of the generator losses. In most actual installations, this feature is not taken advantage of but several methods have been developed and put in practice. With the direct system it is possible to discharge the air into the boiler room and burn it. This is an old idea, but has been employed in only a few cases because of the complication of ducts and because there is available only about half the air required for combustion. With the indirect system using surface coolers it is possible to absorb all or part of this heat by circulating the condensate through the surface coolers. The economies to be derived from any system of this kind, of course depend upon the temperature of the condensate, the load on the generator and the investment charges.

In an installation in the Boone Plant of the Iowa Railway & Light Co. the generator air temperature is controlled automatically to one per cent by means of two coolers, one, the main cooler using condensate as the cooling medium, passing it on to the hot well, and the other an auxiliary cooler, taking water from the condenser circulating water discharge and passing it on to the sewer. Control of operation is through a motor valve under 15 lb. air pressure. As long as the temperature of the air leaving the generator does not increase above normal the auxiliary cooler does not function. If, however, the load on the generator increases, causing the air temperature to rise above 138 or 140 deg. F. the auxiliary cooler is automatically brought into action.

During June, 175 mechanical stokers, aggregating 68,408 hp. capacity were sold as compared with 128 stokers of 44,095 in June, 1925. Twenty-four of these, 2740 hp., were for use under fire-tube boilers, the balance for water-tube.

Welded Steel Stacks Avoid Corrosion at Joints

GUYED STACKS BUILT AT THE SHOP AND ERECTED IN ONE PIECE. SELF-SUPPORTING STACKS BUILT IN PLACE. BOTH TYPES ARE STRONG JOINTLESS STEEL CYLINDERS

FOR SMALLER stacks, the guyed type is commonly used and, if not too long, can be entirely fabricated at the shop with attachments for guy ropes welded on. It would then be transported as one piece and erected by means of a gin pole. If too long for that, it can be made in two or three sections, with all joints welded, then the sections joined on the ground at the site before erection.

Properly made, the welded joint will have at least 80 per cent of the strength of the plate, or as great as most quadruple-riveted joints, or a welded joint can be made stronger than the plate itself, if desired. The single-riveted lap joint, ordinarily used in construction of guyed stacks, seldom has more than 50 per cent of the strength of the plate.

FIG. 1. THIS STACK WAS TRANSPORTED AND ERECTED COMPLETE

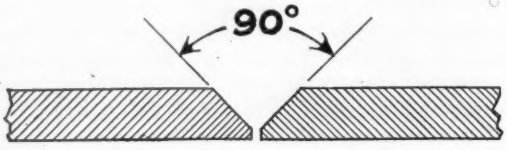


FIG. 2. PLATES OVER $\frac{3}{16}$ IN. THICK SHOULD BE BEVELED IN THIS MANNER

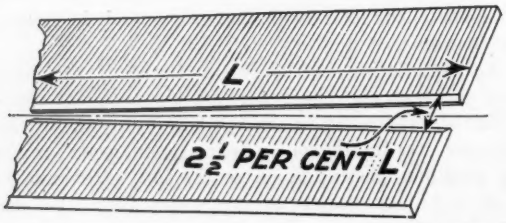


FIG. 3. FOR LONGITUDINAL SEAMS, ALLOW TAPERED SPACING

In self-supporting steel stacks, heavier plate is used, the thickness varying from bottom to top, with double-riveted lap joints and a flared base bolted by a heavy flange to a concrete foundation. These are built up in place, sheet by sheet, and, on account of the weight, the same method would generally be used if joints were to be welded.

Of special advantage in welded stacks is the freedom from joint corrosion. Smoke usually contains sulphurous gases which, with moisture will form sulphuric acid that rapidly corrodes steel. This acid is soluble in water and the edges of lap joints form a place where such liquid can collect and seep into the joints with unwelcome results.

PREPARING THE PLATES

In making welded joints the first step is preparing the edges, beveling them, if over $\frac{3}{16}$ in. thick, either by a planer or by cutting with a blow pipe. The bevel should be at 45 deg. and to within $\frac{1}{16}$ in. of the bottom. Next, the plates are formed by bending rolls and then the longitudinal joints are welded.

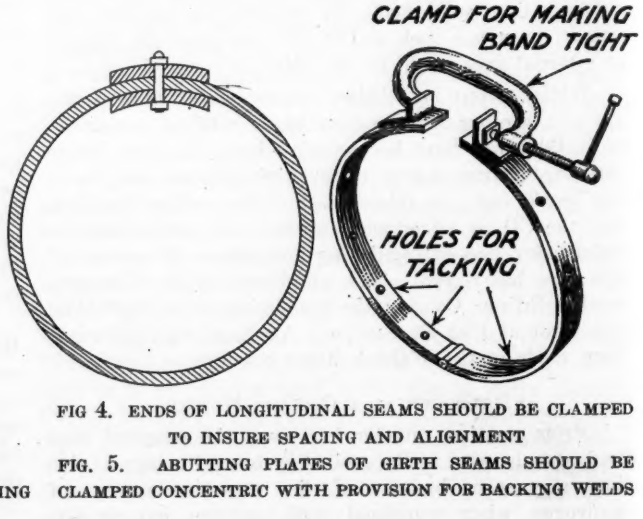


FIG 4. ENDS OF LONGITUDINAL SEAMS SHOULD BE CLAMPED TO INSURE SPACING AND ALIGNMENT

FIG. 5. ABUTTING PLATES OF GIRTH SEAMS SHOULD BE CLAMPED CONCENTRIC WITH PROVISION FOR BACKING WELDS

If beveling has been done with a blow pipe, edges should be cleaned of all oxide by means of a hammer and chisel or a file.

For plates not beveled, the plate edges should be $\frac{3}{32}$ in. apart at the end from which the weld is started and for beveled plates $\frac{1}{16}$ in. At the other end, the separation should be 2.5 per cent of the plate length along the weld or about ¼ in. per ft., but this separation depends on welding conditions and can best be determined by an expert welder.

On circumferential seams, for plates up to ¼-in., unbeveled plate edges should be separated at all points

by the plate thickness plus $\frac{1}{16}$ in. and on beveled plates by the plate thickness. For stacks 36 in. diam. and over, this spacing should be increased $\frac{1}{16}$ in. for both beveled and unbeveled plates.

With the rolled plate on a solid and level base, edges should be separated as given above and held in line and to correct curvature by special clamps, one at each end of the seam, Fig. 4. Care should be taken that there are no flat spots on the longitudinal seams and wedges or pinch bars should be used, if necessary, to make sure that the plate edges draw together properly as the welding progresses.

Weld metal must be thoroughly fused with the base metal and must penetrate to the unbeveled part of the plate edges and to the inside wall of the stack, without laps, cold shuts, gas pockets or oxide inclusions. It is well to have the welding operator make test welds both longitudinal and circumferential and to cut these apart for inspection before going ahead with the main job. The finishing point of the circumferential weld should be specially examined. Width of the weld should be a minimum of 2.5 times the plate thickness and should be reinforced about ¼ the plate thickness.

In placing the sections for circumferential welds, the longitudinal seams should be staggered about 180 deg. Sections should be lined up in horizontal and vertical planes, using rollers and shims and checking by a straight edge or level. Abutting ends of sections should be clamped concentric by means of a ring, Fig. 5, which has holes for back welding at 6 to 8 in. apart. The second tack should be made at 180 deg. from the first, then two at 90 deg. from these and the others successively midway between and on opposite sides to insure proper alignment and control of spacing. Tack welds should be about four times the plate thickness and without reinforcement.

If possible, a seam should be completed without stopping but, if a stop must be made, and at starting and finishing points on circumferential seams, the weld should be heated to a dull red for an overlapping distance of 3 in. and where the weld ties into one previously made, the old weld should be remelted and rewelded thoroughly.

In welding circumferential seams, the work should be done on the upper quadrant, turning the stack as work progresses so as to keep a convenient position for the welder. Where circumferential position welds must be made in the field, the weld should be started from the bottom and completed at the top. Preferably two operators should be used, working simultaneously but, if one operator does the work, he should complete one-half of the circumference, then starting at the bottom and welding the other half, being careful about the reheating and rewelding as previously explained.

The data herewith given have been taken from articles in the issues of Oxy-Acetylene Tips.

THAT ACCIDENTS don't just merely happen, but are caused and that the removal of these causes will result in preventing accidents is emphasized by W. Dean Keefer, director industrial safety division, National Safety Council, who calls attention to the fact that one plant alone has just completed a record of having worked 1,200,000 man hours without an accident.

Noise May Make a Factory a Nuisance

BY LESLIE CHILDS

WHETHER or not the noise incident to the operation of a manufacturing plant may cause serious annoyances to adjoining owners, is a question worthy of careful consideration, before a location for a plant of this kind is settled upon. Especially is this true where it is sought to locate such an establishment in a section of a city that by any chance may be termed residential, for it may be stated broadly that, if the operation of the plant causes sustained annoyance to adjoining owners, the chances are good that litigation for its suppression will follow.

It is, of course, obvious that, since each case of this kind must necessarily be decided in the light of its attendant facts and circumstances, the subject cannot be covered by the statement of any hard and fast rule. As an example of judicial reasoning in a situation of this kind, however, the Pennsylvania case of Hamilton vs. Bates, 131 Atl. 369, is well worth a brief review by industrial executives and owners in general.

FACTS IN THE CASE

In this case the defendants were engaged in the manufacture of ice in the city of Harrisburg. They had been warned by adjoining property owners before the plant was installed that if it caused annoyance legal action would follow. The defendants, however, assured the adjoining property owners that the operation of the plant would not interfere with the comfort of anyone residing in the vicinity and placed their plant in operation.

In this, however, the defendants were mistaken, for, after the plant had been in operation a certain time the adjoining property owners made complaint and filed the instant action to restrain the further operation of the plant. This suit was based on the allegations that the premises occupied by the defendants was in a residential section of the city and that the operation of the plant caused noise and vibrations that materially disturbed the adjoining property owners and their tenants.

In defense to this, the defendants set up that the neighborhood was not residential in character, and offered evidence to the effect that within a radius of a few blocks there was a railroad, freight yards and other manufacturing plants. In addition, the defendants denied that the noise or vibrations incident to the operation of their plant constituted a nuisance.

Upon the trial of the cause, the lower court found that while there were a few retail establishments in the immediate vicinity, there were no manufacturing plants. The court also found that since the railroad, freight yards, etc., were several blocks away, that did not change the character of the immediate neighborhood, which was essentially residential in character.

In addition, the court found from all the evidence that the operation of the plant, which was practically continuous day and night, caused noise and vibrations that seriously interfered with the sleep, comfort and rest of the residents of the vicinity; in view of which the court entered a decree restraining the operation of the defendants' factory. From this decree the defend-

ants prosecuted an appeal to the Supreme Court of Pennsylvania, and here in passing upon the question raised, the court, in part, said:

THE LANGUAGE OF THE COURT

"We are of opinion the court below properly applied the legal principle established in numerous decisions of this court. The mere fact that manufacturing establishments are located within a few squares of the ice plant did not warrant the operation of an annoying business adjoining plaintiffs' homes so long as the more remote industrial developments had not destroyed or interfered with the quiet of the immediate community. * * *"

Following the above disposition of the question of the character of the neighborhood involved, the court directed its attention to the question of whether the operation of the defendants' plant constituted a nuisance. In reviewing the record on this point, the court among other things, said:

"There is, * * * ample evidence to sustain the conclusion that the ice plant, as operated, was a nuisance to plaintiffs and other residents of the immediate neighborhood, owing to the noise and vibrations resulting from such operation. In the front and on the first floor of defendants' building is located a 60-hp. electric motor, used to drive an air compressor and other devices. There are also two 5-hp. motors in continuous operation.

"The air compressor is equipped with a flywheel, 6 ft. in diameter, driven by a 12-in. belt, and a traveling crane runs the length of the building and is operated by a motor. These appliances constitute a part of the manufactory equipment. The plant has a capacity of approximately 22 t. of ice every 24 hr. The product is frozen on the second floor and lowered by elevator to the floor below, from where it slides into a storage room. The factory is substantially in continuous operation, not only on week days and nights, but Sundays.

"Witnesses residing in the adjoining buildings, and also in the immediate neighborhood, testified in effect that the vibration was continuous and distinctly noticeable, especially at night; that it interfered with rest and sleep; that the noise of the motor and the crane was practically continuous; that in some cases it was injurious to the health of the residents, the physician for one of the tenants testifying that the constant noise would have a tendency to cause persons to suffer from nervous breakdown. * * *"

CONCLUSIONS

In conclusion, the court, after a further review of the evidence, affirmed the decree of the lower court enjoining the operation of the defendants' plant, on the ground that it constituted a nuisance to adjoining property owners and residents. Holding, as outlined in the opinion, that the evidence amply sustained the conclusions of the trial court that the neighborhood was residential in character, and that the operation of the plant, as described, should be restrained.

The foregoing Pennsylvania case is one of force and value on the point involved, and, in the light of its facts and holding, it constitutes a striking illustration of the importance of care in locating a manufacturing plant, relative to the character of the neighborhood entered. For, as in the case reviewed, if the neighborhood is in fact residential, and the operation of the plant causes annoyance to immediate residents and tenants, such condition may lead to expensive litigation and perhaps culminate in a restraining order against the plant owners.

Cold Water Removes Slag from Tubes Better than Steam*

BY F. B. WILSON

EXPERIMENTS WERE conducted recently on an installation of Springfield boilers, each having 6280 sq. ft. of heating surface, baffled with Turner vertical baffles and equipped with Coxe forced-draft, chain-grate stokers designed primarily for the burning of coke breeze.

Operating the boilers at 200 per cent of rating with high gas velocities resulted in the formation of slag on the lower rows of tubes. This slag baked on the tubes, restricted the free flow of gases through the boiler, reduced the overload which can be carried, increased the exit temperature of the flue gas and reduced the efficiency of the boiler.

When burning coke breeze this slagging of the tubes made it necessary to shut down the boiler each three or four weeks for the purpose of cleaning, the steam blowers being used daily. As the demand for coke breeze became greater, with a resultant increase in the price of it, a point was reached where it became necessary to discontinue the use of the coke and to burn Illinois screenings on these stokers.

With the change in the fuel came an increased rate of slag deposit on the tubes so that the cleaning period had to be reduced to a week or less, depending upon the overload carried on the boilers. This shutting down of the boilers for cleaning was not only expensive but almost impossible because of lack of excess capacity. For that reason, it was necessary to develop some method of cleaning the tube which would be fairly effective without taking the boilers out of service.

A hand lance having a special head and using cold water was finally decided upon as giving the best results and is now used daily in these boilers. A comparison between steam and water blowing can best be made by observing through the rear door of the furnace the results accomplished by each method. When using cold water the slag breaks off in much larger pieces than with steam and also closer to the tube surface. The reason for this is, no doubt, that the water requires a longer time to become superheated and reaches the slag at a much lower temperature than if steam were used, causing the slag to crack and fall from the tubes. Cleaning the tubes reduces the temperature of the flue gases from 10 to 20 deg. and increases the draft in the furnace by 0.05 in.

At frequent intervals the boiler has been cut out of the line and a high pressure water hose used from the top for cleaning. This is necessary because it is not possible to reach all parts of the boiler with a hand lance while it is in service.

*Abstract of paper delivered at 17th Annual N.D.H.A. Convention, June 1-4, 1926.

The Operator at Corona Falls

By John S. Carpenter

I HAVE a hunch that we're going to change operators at Corona Falls," observed the Assistant Chief, laying down a bunch of charts on the Chief's desk and taking the vacant chair.

The Chief looked up from his favorite magazine and focused his eyes on those of his assistant.

"Jim Morgan's been registering gloom for the last half week," the Assistant continued, "and today I got after him and made him tell me the trouble. He's been courting a school teacher up there and she's turned him down on account of his poor prospects."

"Hmm!" the Chief sympathized, "that's about enough to make anybody feel bad. Did he ask for a raise?"

"Yes, not in so many words, but he told me that she said that people can live on love and biscuits as long as the biscuits hold out."

The Chief reached for the telephone. While he waited he observed, "We can't let him go, he's a good man, has a clean record and keeps that place up there going like a fine watch—Please get me Mr. Morgan at Corona Falls plant."

"Hello, Jim? This is Russell talking—can you come down here tonight? Yes; take the flivver—about eight o'clock, at my house."

The Chief hung up the receiver and started through the bundle of charts. His message had a stimulating effect on Jim Morgan, probably the old fellow had some interest in him, he thought, he always seemed friendly, and by telling him his side of it he might do much better than hunting a new job in a totally strange place. He could hardly wait until eight o'clock came around and he had the lizzie securely tied in front of the Chief's place.

The Russell home is one of those old fashioned places with comfort and welcome written all over it. His greeting was friendly and the two adjourned to the den that also held the Chief's technical library. Evidently he made it a point to keep well informed on technical progress.

"Now tell me," the Chief began, "what you've got on your chest that makes you so glum." Fragrant cigars and a comfortable chair unloosened Jim's tongue.

"To make a long story short," Jim summed up, "she turned me down because she thinks an operator of a hydro plant has mighty little chance of ever being anybody worth while."

"We-el, don't let that worry you, maybe we can make her eat those hard words." The Chief cleared his throat as if to deliver a weighty proposition. "Now, listen, Jim, between you and me, the company has just taken an option on two tracts up in the hill country that are mighty fine power sites. Without a doubt the thing will go through and we are going to put up the biggest thing we have ever dreamed of around here. There'll be a fine chance to get in on the construction end and when we finally get those units pumping juice through the lines it will mean more help for me here. Can you read between the lines?"

"But there's the preparatory work first. Your high school mathematics are probably a little rusty, so you will want to brush up on that first. Get hold of a Wentworth's 'Complete Algebra' and go through it pretty carefully. When you get stumped, put it all on paper and send it down here with your regular daily reports. Then get a good book on Physics. I used Duff's which is very good. Follow that with any of the regular books on elementary mechanics and after that a good book on strength of materials. Then you will want to brush up on electricity and you may be able to get a good used set of correspondence school books on that as they are written for the man working alone. Then get hold of Dan Mead's 'Water Power Engineering' and finish off with Daugherty's 'Hydraulic Turbines' and 'Centrifugal Pumps'.

"They will give you a good basic knowledge of what we use in our work and you will pick up things fast as you go along if you keep your eyes open."

"Evidently you mean, Mr. Russell, that if I buckle down and get a good knowledge of the business, you will back me up with more responsible work and in due time a corresponding pay check?"

"Decidedly, Jim. If we don't, somebody else will, and so far you have a clean record and such men we don't like to see pulling out.

"Where a lot of chaps make the mistake is that they leave one place and take another job at about the same kind of work with someone else, usually at a little more pay. Now, if you prepared yourself for more advanced work the employer has a double incentive to keep you and give you more money. The idea is not to get crystallized in a rut, but to broaden your mind beyond the confines of your present job and thus get the executive viewpoint in your line. But a great many of our men resist all our efforts to get them to study and we have no alternative but to keep them where they are. While we estimate their loyalty at a high figure and do something towards brightening the old age problem by a pension, don't let yourself get so far behind the other men who will be the future executives. Engineering is going forward so fast that the man who will not read and study soon finds he is a back number."

"I guess you're right," admitted Jim, "in fact, I am positive of it. When we keep to ourselves we are likely to forget that there is a great army of active minds working among us and constantly devising some means of getting the jump on the other fellow."

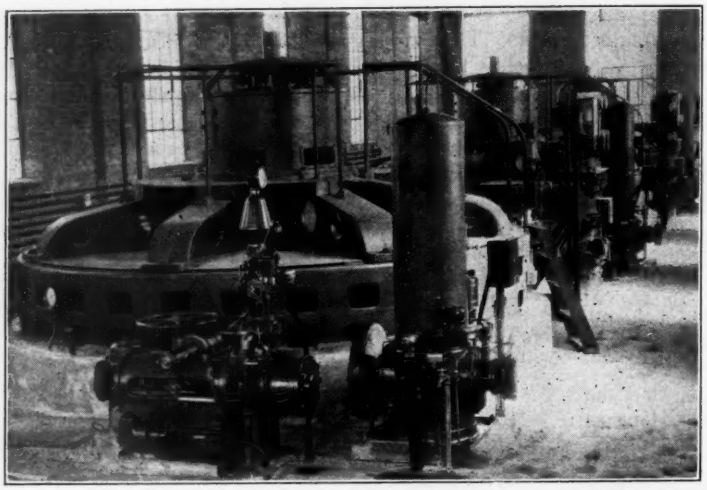
"Yes,—and as for the girl, Jim, some time when you feel like it you tell her what we talked about tonight and I have an idea she may see fit to change her mind when she sees you bringing home the bacon as well as the biscuits. And I'll see about tacking something on the pay check before next payday."

The study was not half as bad as it first looked to Jim Morgan. Before long he was seeing light in many new directions and his transfer to the main office did create quite a little stir and surprise among his acquaintances, who started to do some quiet thinking for themselves and started for the bookstore.

No less surprised was the Chief himself, when, about six months later, he put on his boiled shirt and headwaiter clothes for Jim's wedding!

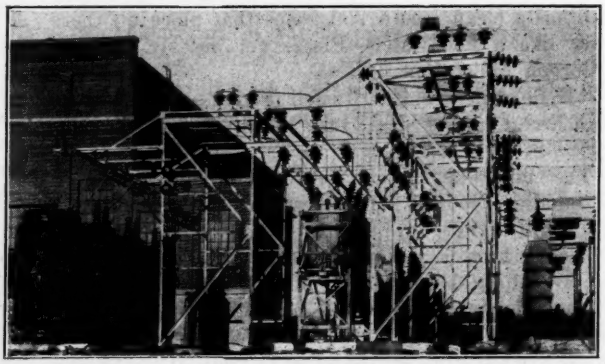
Seeking to obtain an unfair advantage is entirely too common.

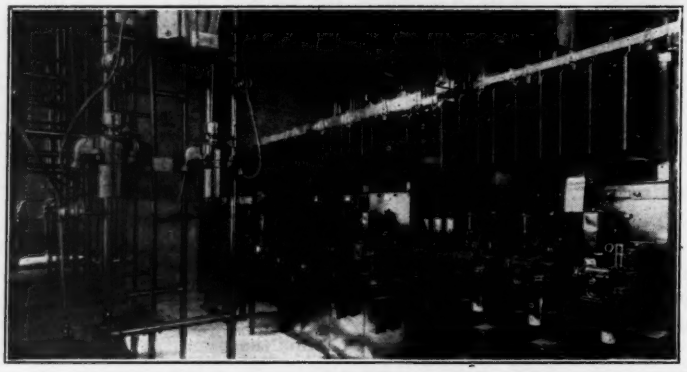
Alexander Dam Automatic Hydro-Electric Plant



Right — At the Alexander Dam Station, Merrill, Wis., operated by the Wisconsin Valley Electric Co., Wausau, Wis., these three 2300-v., 112½-r.p.m., 3-phase, 60-cycle, 1750-kv.a. generators are driven by water wheels under 23 ft. head. Governors are provided with motor-driven flyballs and the station is full automatic. Compressed air brakes are used and a two-stage pump supplies circulating water for thrust bearings. Exciters are direct-connected, 33-kw., 125-v. units. A 40-t. crane is installed.

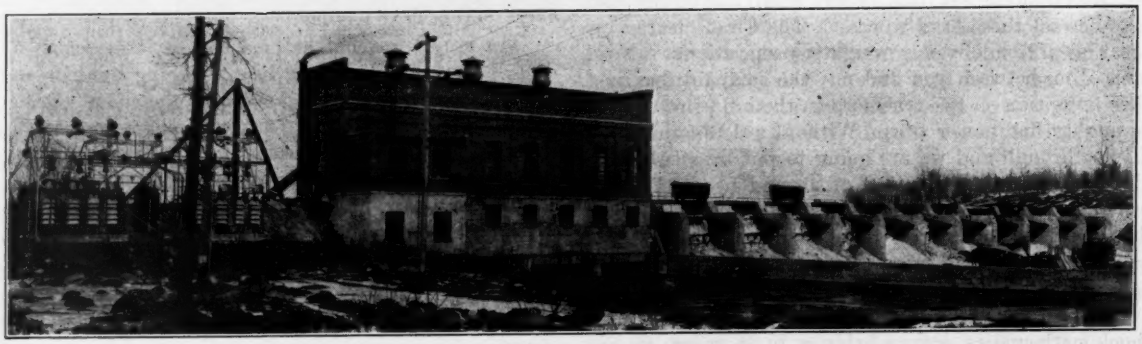
Left — Three 1750-kv.a., air-cooled, oil-insulated transformers step up power to 44,000 v. for connection to system of Wisconsin Valley Electric Co. A similar unit is kept as a spare. These are installed in the outdoor substation as shown, with the oxide film lightning arresters, oil circuit breakers and disconnect switches. Power for controls and circuit breakers comes from a 125-v. battery, with motor generator set for charging floating on d.c. control bus.





Right — Automatic control by pond level puts units on line one by one as pond rises. Synchronizing is by the pull-in method and complete protection is given by protective relays. Board at right carries solenoid-operated breakers. Each unit has own board carrying voltage regulator and relays.

Below — Concrete Ogee section dam has 11 Tainter gates, with gate hoists, and is 465 ft. long shore to shore. Donkey boiler provides heat for building and steam for gate thawing.



Interconnecting Power, Heating and Ice Plants

POWER GENERATING UNITS EXHAUST THROUGH HEATING MAINS TO DISTILLED WATER ICE PLANT DURING SUMMER MONTHS. BY L. A. FOSTER

CONSOLIDATION of utility interests frequently brings forth some unusual arrangements both from a financial and from an operating standpoint. With reference to the latter, there comes to mind a situation resulting from the absorption of the physical equipment of a combination ice and heating plant by the light and heating utility of a fair-sized town. Both had been competing in the business district in the sale of steam for heating, but upon consolidation the heating systems were combined, as shown on the map, Fig. 1.

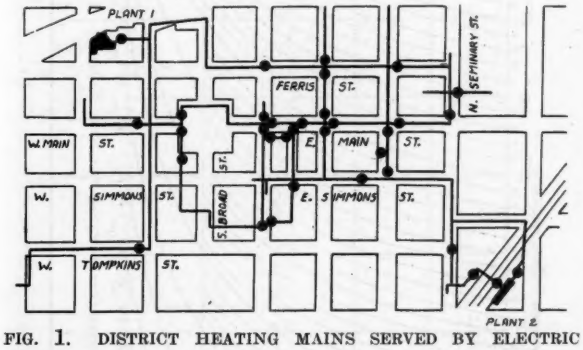


FIG. 1. DISTRICT HEATING MAINS SERVED BY ELECTRIC PLANT NO. 1 WERE COMBINED WITH MAINS SERVED BY ICE AND HEATING PLANT NO. 2

Ordinarily the large electric plant, Fig. 2, designated Plant No. 1 on the map, was operated non-condensing but, during the winter season, the exhaust steam from the electric load was absorbed by the heating system, while any live steam necessary to meet the heating demand in severe weather was fed to the system from Plant No. 2, Fig. 1, which was the ice plant. This arrangement worked out well from an operating standpoint and the revenue from the sale of exhaust steam netted good returns upon the investment in underground steam mains.

After due consideration, it was found advisable to electrify the ice plant, using electric power from Plant No. 1. But as the ice plant was originally equipped to use only distilled water for ice manufacture, it was a question how to supply the necessary condensate during the summer months, as the demand for ice was greatest at this time.

No trouble was encountered as long as the heating season was on, because the condensate returned from nearby buildings was sufficient. Past experience had shown that it was wise to carry a slight exhaust back pressure from Plant No. 1, on the entire underground piping system during the summer season, thus keeping maintenance charges at a minimum. In view of this, it was suggested to increase this back pressure just enough to deliver the required amount of condensate to the ice plant from Plant No. 1, to Plant No. 2 through the medium of the heating system which connects the two plants.

It may be interesting to note that the distance from one plant to the other was approximately 4400 ft. The ice plant produced approximately 50 t. of ice a day under this arrangement while the cost per ton was low enough to allow a good return on the money invested. The electric plant was reimbursed by the ice plant for the slight increase in operating costs due to back pressure carried to deliver the steam over this distance during summer months. The back pressure at the electric plant was 4 lb., while the actual pressure drop was 3 lb. through the 4400 ft. of steam main.

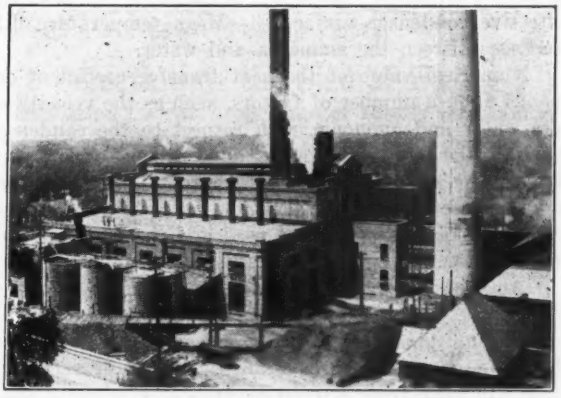


FIG. 2. STEAM ELECTRIC POWER PLANT OPERATED NON-CONDENSING

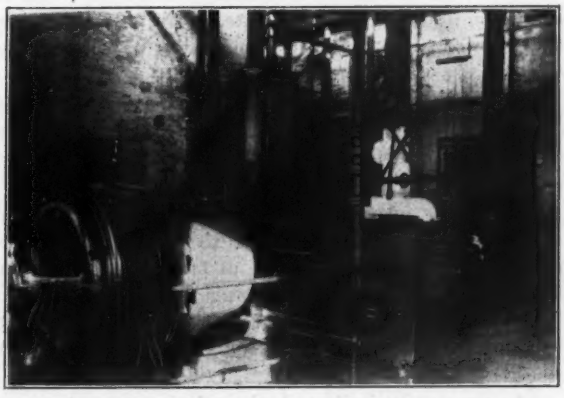


FIG. 3. MOTOR DRIVE WAS INSTALLED ON AMMONIA COMPRESSOR ON PLANT NO. 2

This heating system serves about 250 business houses and residences with a combined load of approximately 250,000 sq. ft. of radiation. There are approximately 5 mi. of steam lines as shown.

THE CENTRAL ILLINOIS PUBLIC SERVICE CO., Springfield, Ill., has concluded negotiations for the purchase of a group of municipal and privately-owned electric light and power plants in nine communities in the state, and will consolidate with its properties. The municipal stations are located at Kinmundy, Middletown and Creal Springs; and the private plants at Farina, New Liberty, Mendon, Littleton, Paloma and Coatesburg. The purchasing station has tentative plans under way for extensions and betterments in the different sections, including transmission line construction.

Ammonia Condenser Operating Characteristics*

VARIATIONS OF AMMONIA AND WATER TEMPERATURES, AMOUNTS AND SURFACES INVOLVED AND OTHER FACTORS INFLUENCE PERFORMANCE. BY W. H. MOTZ

DETERMINING FACTORS affecting the magnitude of the heat transfer in ammonia condensers are as follows: 1—Heat transfer coefficient, usually expressed in B.t.u. per square foot of condenser surface per degree of temperature difference per hour; 2—Area of the effective condenser surface; 3—Mean temperature difference between the ammonia and water.

Numerical value of the heat transfer coefficient depends upon a number of factors, such as the velocity of the water and ammonia with respect to the condenser surface, the presence of scale, oil or other foreign matter on the condition. It will be found that the heat transfer coefficient will vary from 50 to 300, depending upon the kind of condenser used and the disposition of the surface.

Amount of surface used in ammonia condensers is dependent upon the heat transfer coefficient. Under usual conditions, for the types of condensers mentioned, the amount of condenser surface per ton of refrigeration will vary from 4 to 40 sq. ft.

Relative mean temperature difference between the water and ammonia depends principally upon two factors, viz.: the amount of condenser surface used and its corresponding heat transfer rate. This mean temperature between the water and ammonia in the condenser will usually vary from 8 to 16 deg.

Amount of ammonia condenser pressure, for usual conditions, in pounds gage is figured from the initial water temperature as follows: multiply the initial water temperature by 2 and then add 20.

Condenser pressure in pounds gage may be figured from the final temperature of the water as follows: multiply the final temperature of the water by 2½ and then subtract 25. The foregoing rules hold good for the usual amount of surface and water and when there are no noncondensable gases or other foreign matters in the condenser.

As previously indicated, the relative mean temperature difference between the water and ammonia is affected by the amount of surface used. When large quantities of water are used the temperature rises are small, as previously indicated; and conversely, when small quantities of water are used the temperature rises are large. To keep the condenser pressure as low as economically possible, it is customary to use more water as the initial temperature of the water increases.

APPROACH OF CONDENSING TEMPERATURE TO TEMPERATURE OF WATER OFF CONDENSER

As indicated in a previous paragraph, the relative magnitude of the temperature difference between the temperature of the condensing ammonia and the water leaving the condenser depends upon a number of factors. The principal factors affecting this difference of temperature are the amount of condenser surface used and its corresponding heat transfer rate. It is evident that the local conditions such as scale, oil and noncondensable gases, uneven distribution of water, uneven flow of liquid ammonia, disposition of condenser surface, and so on will affect the above-mentioned temperature difference. Practically, it may be stated that

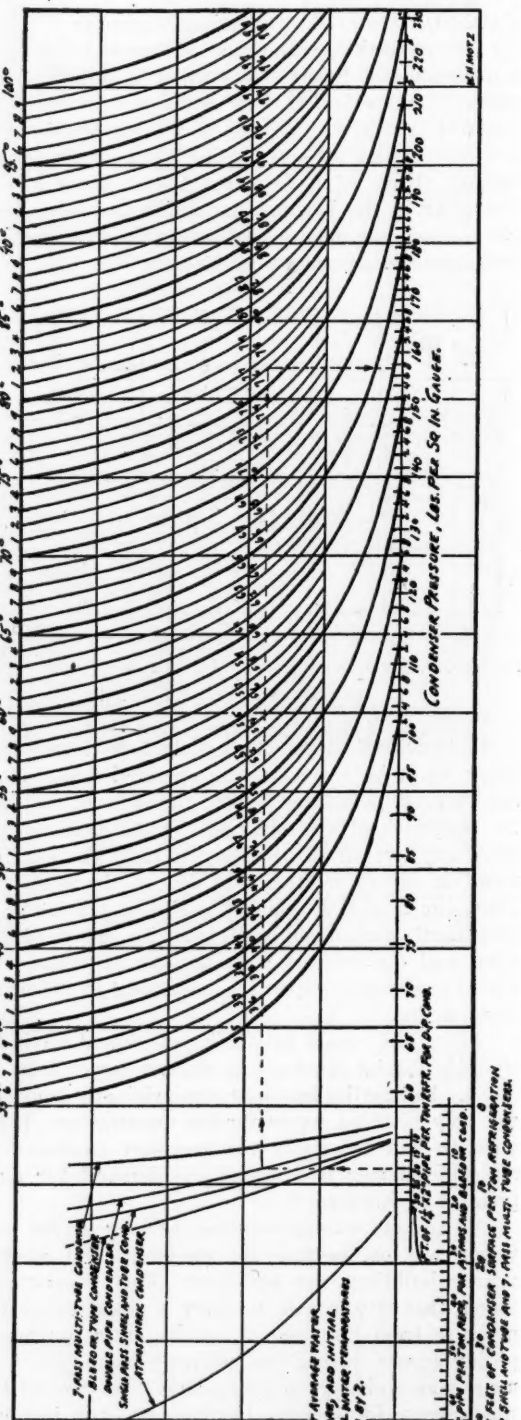

W. H. MOTZ
Condenser Pressure, Lbs. Per Sq. In Gauge.
Tons Refrigeration Saved Per Hour
Note- To Get Average Water Temperature, Add Initial and Final Water Temperatures and Divide by 2.

FIG. 1. UNIVERSAL CONDENSER CHART

*Abstract of paper presented at 13th Western A.S.R.E. meeting June 2-4, 1926.

the above-mentioned temperature difference varies from 3 to 7 deg. An important thing to observe is that the amount of heat to be removed in the condenser varies considerably with the relative condensing and evaporating temperatures in the system. An average practical value for standard conditions is 250 B.t.u. per minute per ton of refrigeration.

Universal Condenser Chart

Using the data given in previous paragraphs and charts, the author has constructed a universal condenser chart, Fig. 1, which gives condenser pressures for any initial temperature of water to condenser, any amount of water used, any amount of surface used, for the five different types of condensers described in this paper.

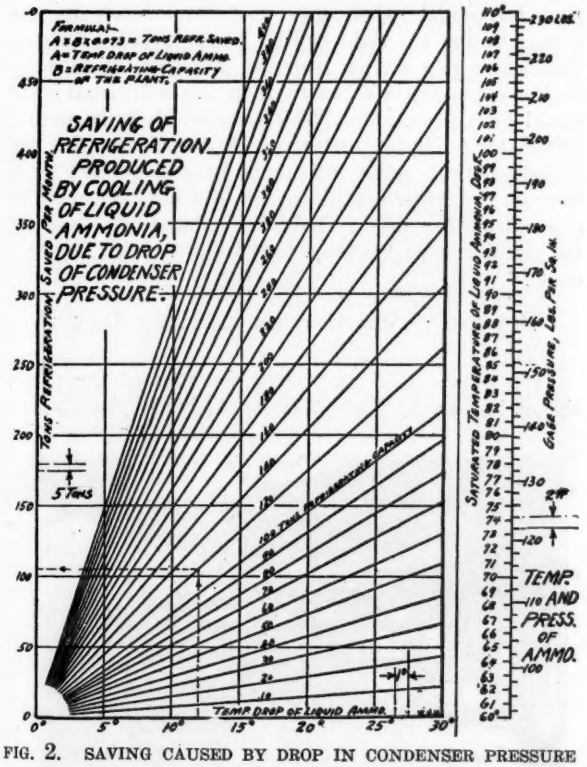

SAVING OF REFRIGERATION PRODUCED BY COOLING OF LIQUID AMMONIA, DUE TO DROP OF CONDENSER PRESSURE.
TONS REFRIGERATION SAVED PER HOUR
5 TONS
TEMP. DROP OF LIQUID AMMO.
SATURATED TEMPERATURE OF LIQUID AMMONIA LEAVING CONDENSER
GAGE PRESSURE, LBS. PER SQ. IN.
TEMP. AND PRESS. OF AMMO.

FIG. 2. SAVING CAUSED BY DROP IN CONDENSER PRESSURE

To use the chart, locate a point on the surface scales, then read vertically to the corresponding curve representing the type of condenser under consideration, then horizontally to the temperature curves representing the average temperature of the water in the condenser, and then downward to the corresponding condenser pressure.

Effects of Foreign Matter

Such things as scale, oil and uneven distribution of water act to reduce the heat transfer rate in a given type of condenser. The uneven flow of the liquid ammonia in the condenser and the presence of non-condensable gases act to reduce the effective condenser surface. The combined effect of all these items increases the mean temperature difference between the condensing ammonia and the water as it passes through the condenser.

After the ammonia condenser has been properly designed and installed, one of the most important factors in its economical operation is the elimination of scale, oil, non-condensable gases or other foreign matter. The different methods of eliminating non-condensable gases are: hand purging into water, hand purging from top of receiver, hand purging through coil into water, one or two direct expansion coil purge drums, automatic purging into air, automatic purging through sub-cooled liquid into air.

Figure 2 shows savings of refrigeration produced by the cooling of liquid ammonia to lower temperatures when the condenser pressures are reduced. For example, if the temperature of the liquid is reduced 12 deg. in a 120-t. refrigerating plant, about 105 t. of refrigeration will be saved in one month.

Selection of the Size of Fuse

Selection of the proper size of fuse is very important, since if the fuse is too large it will not melt out at the proper time and thus will be of no value, while if it is too small it will melt out before the motor has had a chance to do the work of which it is capable. The size of a fuse is measured by the amperes of current that they will carry continuously without burning out. If a line is made to carry 25 amp. it should be fused at not over 25 amp. The rating in amperes is independent of voltage within certain limits, i. e., a 5-amp. fuse will carry the same amount of current on a 110-v. line as it will on a 220-v. line. For 440 and higher voltages, the fuses are made longer so that the danger of arcing will not be so great when they burn out.

Some types of fuses are so made that when they burn out a small black spot appears on the side of the fuse. This is called the indicating type. Many types of fuses do not have this indicator and the best way of determining their condition is by the use of a trouble-light.

Parcel post offers American exporters a low-priced, convenient agency for shipping samples, catalogs, and other advertising material to foreign countries, a Commerce Department bulletin points out. That advantage is being taken of this medium is indicated by the fact that estimates place the value of parcel-post shipments under $25 last year at approximately $25,000,000.

While samples having a market value above a certain minimum are subject to the same rates of duty as levied on regular shipments of the same merchandise, the report discloses that European postal practice is noticeably liberal in its attitude towards the admission of these shipments.

Emphasis is laid on the fact that no advertising matter of any kind should be sent to a foreign customer without all charges being prepaid by the American shipper. As it is not possible to prepay the duty on this class of goods to any European country, the report recommends that the services of a reliable forwarder should be secured or the goods consigned in bulk to an agent to deliver free of cost to the consignee.

The complete report, entitled Shipment of Samples and Advertising Matter to Europe, was prepared in the Division of Foreign Tariffs by Roberta P. Wakefield. It is published as Trade Information Bulletin No. 145 (Revised). Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., or any of the district offices of the Bureau of Foreign and Domestic Commerce. The price is 10 cents.

Ice Plant of the Lima Ice & Coal Co.

MEDIUM-SIZED PLANT, REMODELED TO DRIVE ALL MAIN UNITS FROM ONE FLYWHEEL TYPE SYNCHRONOUS MOTOR, SHOWS LOW COSTS

AS AN EXAMPLE of what may be done in remodeling an old ice plant of medium capacity at a minimum expenditure and yet operate with high economy, the ice plant of the Lima Ice & Coal Co., Lima, Ohio, contains many features of interest.

With a nominal output of 30 t. daily, the plant has a yearly output of approximately 8000 t. This is made possible by its 3000 t. ice storage capacity, a feature that it already possessed before remodeling.

This plant was installed 17 yr. ago, using a 30-t. Carbondale exhaust steam absorption machine. All was well

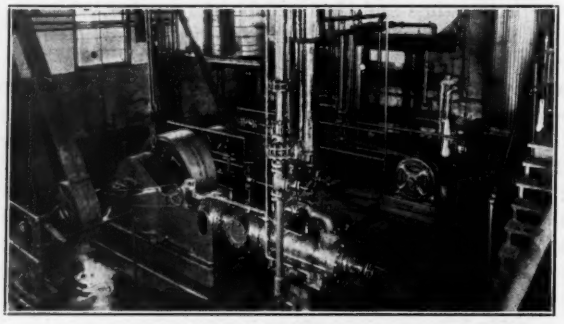


FIG. 1. FLYWHEEL TYPE SYNCHRONOUS MOTOR ON COMPRESSOR ALSO DRIVES AIR COMPRESSOR AND DEEP-WELL PUMP THROUGH LINE SHAFT

as long as its 10-yr. contract lasted with a nearby power plant, under which exhaust steam was obtained for almost nothing, in consideration of all auxiliaries being motor driven. But when this contract expired, the rates became too high and the storage house was added with the idea of making ice during the winter months, lower rates being promised for power if operation could be continued during the time of the power plant's winter heating load.

About 6 yr. ago, a 25-t. York enclosed case ammonia compressor was added, belt-driven by a 40-hp., G. E. motor, with its own double pipe condensers, brine tank and brine coolers for carrying the storage rooms. Two centrifugal brine pumps were also put in, one of 220 g.p.m. capacity driven by a 7.5 hp. motor and the other of 90 g.p.m. capacity driven by a 3½-hp. motor, for circulating brine through the storage room coils. The above compressor is now kept as a standby unit.

DEEP WELL FURNISHES WATER AT 53 DEG.

A 150-g.p.m. Downie double-acting, deep-well pump, furnished by the Keystone Driller Co., belt driven from a 15-hp. motor, had been installed when the plant was built. As the well water averages 53 deg. and the pump is a highly economical one, this was a valuable asset.

The ice tank contains 480 cans, of 300 lb. capacity each, but the pipe coils are alternately 6 and 8 pipes high. Today such coils in economical motor-driven plants would be made 10 pipes high. With an absorption machine, low suction pressures made little difference, due to limited coil surface, although trouble had always been experienced from slopovers to the machine, reducing its capacity and efficiency. In electrifying the plant, this became a serious problem. The tank was not deep enough for 10-high coils and the frame work would have had to be destroyed to make them even 8 high.

BRINE COOLER GIVES ADDED TANK CAPACITY

So the tank was left unchanged, except for the addition of air laterals and mains, designed for a Martocello medium pressure drop tube bracket system. A 25-t. vertical Carbondale shell-and-coil cooler, shown in the background at the right in Fig. 1, was installed instead. This serves as a suction trap and increases the capacity of the expansion side more than the additional coils would have done. The 220-g.p.m. Goulds brine pump, driven by a 7½-hp. motor, which also drives the two horizontal tank agitators, pumps brine from the tank, through the cooler coils and back into the tank at small expenditure for power. This arrangement also increases the circulation in the tank, so that 40 t. of ice has been made.

FLYWHEEL TYPE SYNCHRONOUS MOTOR DRIVES COMPRESSOR

The outstanding feature of the new engine room, shown in Fig. 1, is the 9-in. by 14-in. single-cylinder,

FIG. 2. GENERAL VIEW FROM ICE TANK TOWARDS MACHINE ROOM

double-acting, Worthington Feather valve ammonia compressor, installed by the Carbondale Machine Co. This is driven by a 100-hp., 2200-v., 3-phase, 60-cycle Ideal flywheel type synchronous motor, one of the first of this type to be used in an ice plant. Excitation is provided by a small Ideal motor-generator set.

This is exactly the reverse of the ordinary motor, the stator being around the shaft, although bolted to the compressor frame. The rotor forms a part of the flywheel, four times the ordinary flywheel effect being obtainable.

Two features of this compressor are the double seal stuffing-box between the frame of the compressor and the cylinder and the clearance pocket head or unloader. In the stuffing-box, France floating metallic packing is used next the cylinder and John Crane in the outer

part. As the space between is connected to the suction line, only suction pressure is carried by the outer packing. This practically eliminates rod leakage. If necessary, it is possible to get at the inner packing through a hand hole plate. The clearance pocket head cuts the capacity of the compressor, its power consumption and its maximum demand almost proportionately. In other words, it is a "2-in-1" compressor.

All Main Units Driven From One Motor, With One Loss

Two 8½ by 9-in. Worthington single cylinder Feather valve air compressors were installed. The reserve compressor is belted from the 15-hp. motor formerly driving the deep-well pump. The other compressor is driven by belt from a line shaft provided with roller bearing hangers. The line shaft is belt driven from the ammonia compressor, as shown. The deep-well pump is now driven from this same line shaft. It was the intention to drive as nearly as possible the whole plant from the compressor motor and have the benefit of its highly economical operation and one motor loss. This has reduced the power consumption to a surprising extent. It is possible to run the ammonia compressor without running the line shaft, since the driving pulley on the compressor shaft is a friction clutch pulley.

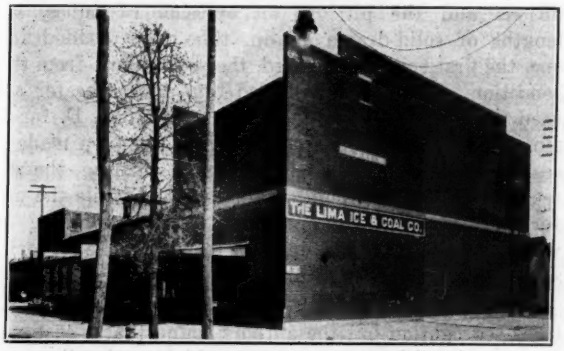


FIG. 3. EXTERIOR VIEW SHOWS 3000-T. STORAGE ROOMS, WITH MACHINE ROOM AT FARTHER END

Condenser water from the deep-well is sent to a Carbondale Spira-flow condenser installed just outside the wall of the machine room. This condenser, of the vertical shell-and-tube type, is enclosed by a wooden casing, carrying louvres to give good air circulation about the unit. It has been found that the installation of the condenser out of doors has materially improved its operation. From the top of the ammonia receiver a ½-in. equalizing line is led to a point about 4 ft. from the bottom of the condenser to prevent liquid from pocketing in the feed line from condenser to receiver.

Old Rectifier Used for Heating Thawing Water

Before going to the condenser, the discharge line from the compressor passes to the second floor of the machine room where it is connected to a rectifier taken from the former absorption plant. This rectifier removes enough heat from the discharged gas to heat water to about 100 deg. for thawing ice at the dump and, by cooling the gas on its way to the condenser, increases the capacity of the plant. An oil trap is interposed between rectifier and condenser and the cooling of the gas makes it easier to extract the oil from it.

Figure 2 shows the ice tank. Cans are pulled two at a time, but plans are now being made to pull three at a time. All water used for ice-making is treated by an International Filter Co. water softener, using the lime and alum process, the large tank in the background of Fig. 1 being the settling tank for this softener.

On the second floor of the machine room is located the mixer for the water softening chemicals. The softener uses about ¾ lb. of alum and 10 lb. of lime for 30 t. of ice a day. Another item of interest here is a Yale & Towne 3-t. hoist, driven by a 3-hp. G. E. motor, installed on the second floor directly over the deep-well pump. This is used to pull rods out of the well and to handle parts of the pump when repairs are necessary. It proves especially useful when only one man is on duty since, if any work has to be done on the pump, he can do it alone, the motor control for the hoist being located below near the pump. Several power-driven machine tools are provided for ordinary repair work about the plant.

TABLE I. BASIS FOR COMPUTING POWER CHARGES AT LIMA PLANT

Yearly Load Factor, per cent	Yearly Charge per kv.a.	Kw-hr. Allowed per yr. per kv.a.	Rate per kw-hr. in excess
40	66	3723	1.90
45	69	4161	1.77
50	72	4599	1.66
55	75	5037	1.56
65	81	5913	1.42
75	87	6789	1.32
80	90	7227	1.30
85	93	7665	1.28
90	96	8103	1.26
95	99	8541	1.20
100	102	8760	1.23

On the main machine room floor is provided a complete switchboard carrying motor control switches, demand meter, kilowatt-hour meter and all other necessary electrical equipment. Power for all plant motors, except the main flywheel-type synchronous motor, is stepped down from 2300 to 250 v. by a bank of G. E. transformers mounted on a pole just outside the plant.

Power Rate Is Based on Yearly Maximum Demand

The present power rate is based on a yearly maximum demand figured in multiples of 25 kv.a. with a discount for power factor correction and with load factor also taken into account. Table I shows how the rate is figured and Table II, the discount for power factor correction.

The actual maximum demand at present is about 80 kv.a. and, if this could be reduced to 75 kv.a., a large saving could be made.

In order to do this, several plans are being considered. It might be possible, by putting in another condenser, to reduce the condenser pressure and thus lower the maximum demand. Consideration is also being

given to driving the air compressor with an oil engine, since the operating costs of such a drive would be much less than the saving due to reduction of maximum demand. Further, a spray system has been installed on the roof to aerate the condensed water and get rid of the sulphur it contains and it is planned in winter to shut down the deep-well pump and to circulate city water in the spray system and thence to the condenser, thus saving more power.

Manipulation of Clearance Pocket Helps in Keeping Down Maximum Demand

In the operation of the Lima plant, some care is needed in handling the equipment on account of the fact that the power charge is a yearly maximum demand charge. For example, operation of the 3-t. hoist might cause the maximum demand curve to rise sharply and the high point reached would then form the basis for

TABLE II. DISCOUNTS ALLOWED FOR POWER FACTOR CORRECTION

100	per	cent	p.f.	decreases	rate	4.9	per	cent
95	"	"	"	"	"	3.5	"	"
90	"	"	"	"	"	1.9	"	"
85	"	"	"	"	"	0	"	"
80	"	"	"	increases	"	2.3	"	"
75	"	"	"	"	"	5.	"	"
70	"	"	"	"	"	8.3	"	"
65	"	"	"	"	"	12.5	"	"
60	"	"	"	"	"	17.9	"	"
55	"	"	"	"	"	24.6	"	"
50	"	"	"	"	"	33.6	"	"

computation of the power charge. It has been found, however, that by proper manipulation of the clearance pocket on the compressor when this auxiliary is in use, it is possible to keep the power curve of the recording maximum demand meter practically a straight line. Similarly, when using air for driving a turbine cleaner through the condenser tubes, to prevent deposits from raising the head pressure, an additional load is put on the motor, which can be reduced by opening the clearance pocket. Plans are being made to install an electrically operated device to open the clearance pocket when any of these small plant auxiliaries are put in operation, thus preventing the establishment of a high maximum demand.

Another important factor that reduces the overhead at this ice plant is the making of approximately one-half of the plant's total sales direct from the platform during the summer months. This arrangement has resulted from a carefully planned advertising campaign and contributes much to the economy of operation.

Taken all together, this little plant forms a splendid illustration of how attention to small details secures operation at low cost, with convenience and satisfaction to owners and operators. Engineering work at the plant of the Lima Ice & Coal Co., described here, is directly in charge of C. A. Fisher, under the supervision of Joseph Engelhard, president of the company.

Rochester Gas & Elec. Corp. is perfecting plans for construction of its proposed hydro-electric light plant on Canada Creek.

Segregation of Material in Boiler Tubes Causes Pitting

FOR MAKING tubes for boilers and superheaters, it has been believed that non-piping ingots, which have some formation of blow holes instead of a shrinkage cavity, are desirable. As these are pierced in making the tubes, blow holes and the segregated material, which analysis shows to be higher in manganese, sulphur and phosphorus than the uniform metal, are left in the interior of the tube where they are subject to the action of steam and water. Sulphur prints of tubes, made by Messrs. G. R. Woodvine and A. L. Roberts, who have reported the whole investigation in a paper before the Iron and Steel Institute in London, show the segregation to vary with different tubes but a bad segregation of sulphur at and near the inner surface to be evident in most instances.

To determine what relation exists between such conditions and the pitting or corrosion of tubes, two lengths of solid-drawn 1½-in. tube were welded into one, the first being segregated, the second free from that condition. The tube was coiled into a superheater and used under 200 lb. and from 600 to 700 deg. F. for 12 mo. when perforations appeared in the portion made of segregated tubing. On removing and splitting, the segregated section was found badly corroded while the uniform section was sound and but little the worse for wear. Scale from the interior of the pitted portion showed 0.19 per cent sulphur on analysis.

It was found difficult to get tubes which did not show segregation but the authors found that a cast steel ingot made with the same care as high-grade alloy steel ingots gave tubes which were free from segregates and laboratory tests have shown no failures of these from corrosion or pitting.

Boiler Output Doubled in 11 Days

POSSIBILITIES of quickly increasing the output of an operating steam plant have been strikingly shown by a recent installation of Taylor stokers under two 500-hp. boilers at the Solvay, N. Y., plant of the Atmospheric Nitrogen Corporation. It became necessary recently to increase the output of these two boilers with minimum loss of time in operation.

Under a contract placed with the American Engineering Co., the first stoker together with a new ash hopper and the new brickwork required was installed, in six days. The second unit was similarly installed in five days. During the installation of the first unit, the second boiler was continued in operation, and during the installation of the second stoker, the boiler under which the first stoker was installed carried the entire load, operating at from 225 per cent to 250 per cent of rating, with peaks up to 300 per cent. For more than a week, this boiler supplied more steam than both boilers together had delivered previously, and it is stated that the plant is now able not only to supply more than double the original amount of steam, but also to do this at a marked increase in efficiency.

Receiver Pressure for Compound Engines

IN THE July 15 issue, page 815, the article under the above title has attracted my attention and also brought to mind another interesting article that I had read some time ago relative to lead, compression and receiver pressure for steam engines. This article appeared in the April 1 issue of Power Plant Engineering, page 418, under the title of "Improvement of Engine Performance."

Many engineers run their compound engines with a receiver pressure derived from a "guess." Someone had told them that so and so many pounds receiver pressure was the right thing, so they let it go at that. Your rules, therefore, at least will give those who may read them an idea as to what is about right.

Some years ago I took charge of a power station (electric railway) in which engines of various sizes aggregating 10,000 hp. capacity were installed. They were all two-cylinder compound, some tandem, and other cross compound, and all condensing. Boiler pressure was carried at 150 lb.; the receiver pressure was carried at 5 lb. gage. Upon asking the question as to why 5 lb. was carried, the answer given was that the man who had erected and installed the engines had told them that 5 lb. was the correct pressure to carry and that settled it for once and all.

Indicator cards were taken from both cylinders of the engines and it was found that most of the work was being done in the high-pressure cylinder of all the engines in the plant. Before getting through with experimenting with different receiver pressures, we found that for the load carried during the greater portion of the 24 hr., 25 lb. receiver pressure gave the best results. In brief, from experiment and by checking up with indicator cards, we found that the governor ran in the highest plane at 25 lb. receiver pressure and this meant the least steam consumption to carry the load. This also checks up with the rule given on page 815 in the July 15 issue, the cylinder ratio was 4 to 1, then, according to your rule, 150 lb. boiler pressure, or 165 lb. absolute,

$$\frac{165}{4} = 41 +, \text{ and } 41 - 15 = 26 \text{ lb.}$$

I may say that nearly all compound engines that I have seen during my long experience in engineering were running with a receiver pressure too low for best results.

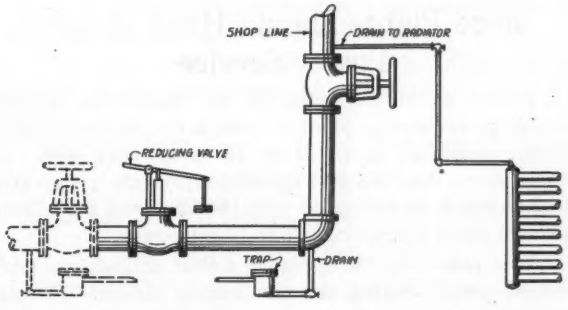
Now a few words about compression. R. H. Morris, in the April 1 issue, has covered that splendidly. To those interested, and who may not at the time have read it, I would suggest looking it up and make a study of that most excellent article. Briefly, my experience has been to carry as little compression as consistent with quiet running, and never more than enough to fill the clearance spaces for the beginning of the stroke. Do not use live steam lead to fill clearance spaces and, to cushion the on-moving piston, use exhaust steam and use only enough to accomplish the purposes referred to. This is pretty close to that given by Mr. Morris in his article.

Finally, with regard to lead for steam engines, most engines would do better with no lead at all. This, independent of size, or speed at which the engine runs. If an engine must be given steam lead, then from all that I have read on the subject and from my own experience, the only factor that should be considered is that of clearance. Small clearance would mean small lead, and larger clearance, larger lead. Of course, it is to be assumed that the engine has been designed for a given piston speed and that the steam parts have been properly proportioned to permit the steam to function properly.

Brooklyn, N. Y. CHARLES J. MASON.

Water Hammer Caused by Undrained Pockets

UNDER THE above title in the July 15 issue, p. 811, Fig. 2, Robert A. Althaus shows an idea of draining condensate from the shop steam line. I think that if he



RELOCATING THE STOP VALVE AND TRAP AS SHOWN BY THE DOTTED LINES WOULD GIVE BETTER SERVICE

would relocate his steam stop valve ahead of the reducing valve, with the trap ahead of the stop valve, he would have a better arrangement. I don't know how he traps his radiator or how he provides for drainage in the summer time but I do think another trap would pay for itself if he doesn't want to change his stop valve.

North Dighton, Mass. W. R. MOYNAN.

This Plant Needs Competent Operators

IN THE July 1 issue, p. 764, under the above title, the article by L. A. Cowles certainly hit a sore spot in the industrial manager's anatomy when telling about some of the stunts pulled off by high salaried engineers who learned all about power plants from carrying ashes out of the kitchen stove.

All such mistakes, however, are not made by this type. Several years ago a consulting engineer for a large industrial concern had a variable capacity centrifugal pumping unit and fitted up a float controlled valve on the pump suction to vary the capacity of the pump. That is, he throttled the suction rather than the discharge and, in spite of the objections from the operating engineer and manufacturer's representative, he had it put in service. From test results he showed a slight power savings over the discharge controlled system. This worked up into a yearly report looked like a million dollars. He applied for a patent and the general manager of the concern thought it was a good joke to put something over on the manufacturers in spite of all the research they were supposed to be doing.

About five months later it was a sheepish looking engineer who ordered his invention scrapped. The pump stopped pumping one day and the chief had the inventor down for an inspection. The pump casing looked like a piece of sponge, in some spots the cast iron had been almost entirely eaten through and a screwdriver could be punched through the remaining shell. The brass impeller was even badly eaten around the eye and the beginning of the vanes.

Throttling the suction at light loads had produced a high suction and cavitation had resulted. Oxygen dissolved in the water had been released and lost no time in getting in its corrosive work.

The loss of time and about $850 for a new pump made quite a showing against the few dollars theoretical power savings and nobody heard anything of the remarkable invention after that.

Los Angeles, Cal. B. MARKER.

More Plants Should Have Double Power Service

I WAS MUCH interested in the description of the double power service plant of Ginn & Co., in Cambridge, Mass., published in the July 15 issue, page 809. It seems to me that this arrangement represents a sane and logical trend, as compared with the wholesale rush from private plant operation to purchased power.

This plant will be operated almost entirely on purchased power during the non-heating season. During the heating season the steam required for heating will be passed through the engines on its way to the heating system. The engines will be run in parallel with the purchased power conversion equipment (motor-generator sets in this case), which will supply the balance of the power needed. The amount of power generated will vary with the weather; in severe weather a greater portion of the power required, or perhaps even all of it, will be supplied by the engines; and in milder weather, or as the heating season tapers off, a greater portion of the current needs will come from the motor-generator sets. No steam will be wasted to the atmosphere.

Occasionally we hear a consulting engineer boast, "My business is shutting down private power plants. Down with them; they're the bunk," or words to that effect. Of course, nobody questions the fact that the isolated plant is no longer in its heyday, or that the general trend towards the purchase of central station current is in most respects healthy and logical. But the isolated plant still has some uses, especially in cases where there is a heavy heating load, and where the necessity for continuing the use of direct-current equipment makes current conversion equipment necessary. This usually means that something in the way of a skeleton operating force has to be maintained, regardless of whether all of the current is purchased or not.

Nor is this system, which might be termed "Combination Operation," entirely detrimental to the interests of the central stations. The load on these plants usually is considerably heavier in the winter than in the summer, and that means that the utility must carry sufficient generating equipment, not only to take care of its winter-time evening peak loads, but also to provide adequate reserve capacity for winter-time emergencies. The result usually is that summer finds an appreciable amount of idle equipment that continues to eat up fixed charges without producing any revenue.

Companies that realize this often make it easier for the isolated plant owner to work out a feasible scheme of combination operation by reducing his winter demand. For example, a contract calling ordinarily for a minimum demand of 300 kw. and a maximum of 450 kv.a., would be reduced for the six months of the heating season (October through March) to a minimum requirement of 200 kw., and a maximum of 300 kv.a.

We often read about a company which has closed down its isolated plant as far as power generation is concerned, is using its boilers only for heating steam and is buying all its current. Maybe its owner is thoroughly satisfied, or even enthusiastic; often he has occasion to be. He may have been so cramped for space that his engine room space had become far more valuable for manufacturing purposes than for power generation; or, more likely, his power plant had become so obsolete that almost any sort of a change would have made an improved showing. In many cases, though, he might have worked out a plan for combination operation that would have provided two independent sources of power supply, would have given him an extremely flexible system and would have saved him a considerable amount of money.

There is another trend that is slowly developing in the public utility field that will close down a lot more isolated plants and this time it will be an entirely healthy development. Steam at 800-1500 lb. pressure and considerably superheated will be passed through the turbines and be exhausted, during the heating season, at 125 to 200 lb. pressure, into central heating mains. Heat will be supplied to buildings in the business districts, even at considerable distances from the generating stations, on a competitive basis. During the non-heating season the turbines will exhaust directly to the condensers, and during mild weather in the winter the heating steam will be bled. When this development has moved farther along then there will seldom be an excuse for an isolated plant in a city. Until then, a plan of combination operation is well worth consideration.

North Glenside, Pa. W. J. RISLEY, JR.

Cast-Iron Sleeve Protects Fire Tubes

IN ANSWER to the inquiry of Charles J. Virgin in the June 1 issue, p. 664, under the above heading, I may state that I have had personal experience with this device in the U. S. Navy. It was tried out in both the British and American Navies some years ago, being used for the protection of the tubes from the direct action of the heated gases, in particular with tubes that had been thinned with several rollings.

It was fitted to stop leaky tubes by preventing the overheating of the tubes and tube plates at their joints. The cap protected the tube end from the direct heat, while the face of the ferrule received the heat that otherwise would have affected the tube end. This heat was conducted along the tube until the plate was well passed, a space having been left to keep the heat at a certain distance from the tube end. The space thus formed provided a non-conducting air space between the ferrule and the tube. The ferrule was made slightly tapered so that it would be forced into the tube forming a shield and support.

This device offered good protection to the tubes but had a number of disadvantages. In the case of tubes under 2½ in. diameter it proved a serious impediment to the draft. It may be seen that the purpose of the ferrule was to receive heat on its face and sides and to conduct it into the tube at a certain distance from the plate; if this distance was appreciable, the ferrule would get hot and, after a time, slag was deposited in the mouth of the ferrule. The longer the air space the hotter the ferrule became and the deposit soon began to accumulate in a clinkery form, thus choking the tube.

If the air space is shorter, the ferrule will keep cooler and work clear but there will be greater risk of the tube joint heating and eventually leaking. It is the most efficient if the air space is the same length as the diameter of the tube in which it is used. To have this device work properly it should be cleaned often and there should be intimate contact between the ferrule and the tube. Sometimes it is advantageous to remove the ferrule and clean both it and the tube at the point of contact since it is evident that poor contact between the ferrule and tube has the effect of making the air space longer and prevents the proper transfer of heat from the ferrule to the tube, thus causing overheating. Properly taken care of, this sleeve is of benefit in preventing leaky tubes but, if this is not done, it is useless. Before installing these sleeves one should consider whether the conditions of his plant are such that he has time to keep them clean. They should be formed of malleable iron.

Racine, Wis. FRANCIS V. GREENE.

Paying Workers—Cash vs. Checks

IN THE July 15 issue, p. 817, under the above heading you present an interesting comparison of the advantages of paying workers by check or by cash. The opinions were those voiced in questionnaires sent out by the National Industrial Conference Board.

It seems to me that the check plan eventually will be almost universally adopted, and that the objections to this system can readily be overcome.

The first objection offered is that checks are always liable to forgery or raising. Present-day methods of check-printing and the wider use of safety paper have made it much more difficult to alter a check without detection. Further, workers' pay checks usually have printed on the face "Not good for over $100." A check that cannot be made to yield over $100 after alteration will not offer much inducement to a forger, because the risk is too great for the gain.

The second objection offered is that the check system entails extra work by executives in signing checks. It is not necessary that the same company officials who sign the regular company checks should sign the payroll checks. A responsible employe of the accounting or payroll department can be bonded and given the authority to sign the payroll checks. Some such arrangement as this is often made in large companies for taking care of small payments.

Another objection offered is that many employes prefer cash, since they are inconvenienced in getting funds readily. This usually is a matter of education. When workers have been accustomed for many years to receiving their pay in cash, it is quite natural that many of them will show no enthusiasm on the change of plan. It is the company's duty to point out the reasons for the change, and to show them how the change will benefit the men themselves.

Inconvenience in getting funds has often been experienced by companies changing to the check plan of payment. This difficulty was a considerable puzzle to a company for whom I formerly worked, when it changed its system. Workers complained constantly that they could not get their checks cashed, and they were clamoring for a return of the cash-and-carry plan.

At first the company had arranged with two banks located within three blocks of the plant, to cash payroll checks for employes, regardless of whether accounts were carried there or not. Then the company changed the pay-time from evening to noon. Complaints stopped almost immediately, and the two banks picked up a surprising amount of new business, both in small checking accounts and in savings accounts. Some of these accounts were started by workers who had scarcely known what the inside of a bank looked like.

The check plan certainly should be given careful thought by the management of any plant not using the system.

North Glenside, Pa. W. J. RISLEY, JR.

Cast-Iron Fittings Are Not Suitable for Superheated Steam

ON PAGE 713 of the issue for June 15, 1926, there is a letter suggesting the addition of superheaters to the ordinary h. r. t. boiler installation and implying that this would not require any other changes.

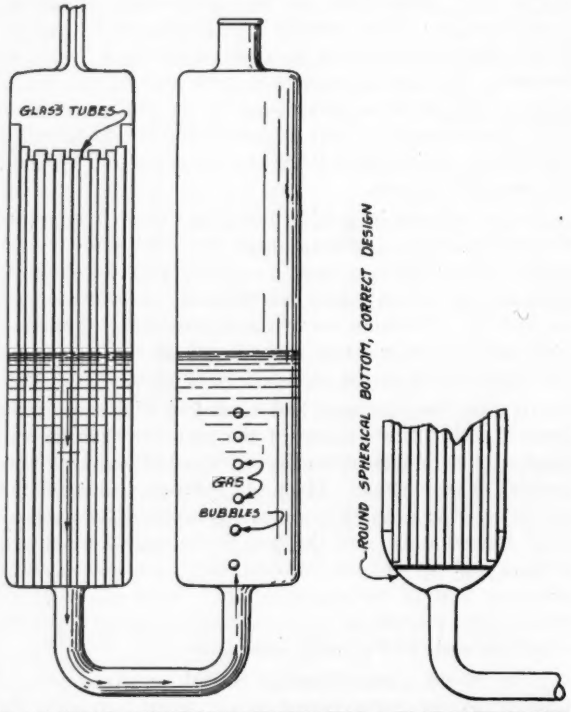
A warning should be given that superheated steam should not be used with ordinary cast-iron fittings. The writer has in mind an accident where a cast-iron steam separator, though designed for a pressure much above that used, burst and injured a workman and the only explanation to be found was that the separator was designed for saturated steam, whereas 75 deg. superheated steam was used.

Pittsburgh, Pa. R. E. BUFFINGTON.

QUESTIONS AND ANSWERS

Maximum CO_2 Obtainable from Fuel

IN REFERENCE to the article by M. S. Gerend, under the above title, in the July 15 issue, p. 815, I find that his figures for the gas analyses with various amounts of excess air are substantially correct but, to be exact, for 15 per cent excess air, the CO_2 content should be 17.5 per cent. Local samples, which cannot be considered as representative ones, are of no value when judging the combustion or figuring the amount of excess air or of unburned gases; all they indicate, when compared with an average, representative sample, is the thoroughness of the mixing of gases in the furnace. Yet, Mr. Gerend states that the analyses given are local samples. The same applies to instantaneous samples, which do not represent an average in time, the same as a local sample does not represent an average in space.



IF AN ORSAT ABSORPTION PIPETTE HAS A FLAT BOTTOM THE GLASS TUBES MAY BE SO LOCATED THAT GAS WILL ESCAPE THROUGH THE REAR AS SHOWN AT LEFT. CORRECT FORM OF PIPETTE IS SHOWN AT RIGHT

If hydrogen escapes unburned there will be more CO_2 in the gases than calculated, either with the aid of the chemical formulas or found from a diagram. In an article in the April issue of Mechanical Engineering, I described these cases (see page 333, last paragraph), and called the amount of CO_2 for the special case, in which all the hydrogen escapes unburned and all the C of the fuel is burned to CO_2, CO_2 ultramaximum. For the fuel having an analysis as given by Mr. Gerend, this CO_2 will amount to 31 per cent. Analogously, there also is a CO_{um}, which will amount to 41 per cent. I could not find any combination, however, which would check with the analysis obtained from the small experimental furnace of Mr. Gerend. On the contrary, I could prove mathematically that those combinations could not have been formed through combustion.

Taking, for example, the second analysis, of the 50.31 per cent C contained in the fuel, considering the ratio of 22 per cent CO_2 to 9 per cent CO in the gases, 35.7 per cent was burned to CO_2 and 14.61 per cent to CO, giving 10.8 cu. ft. CO_2 and 2.22 cu. ft. CO per lb. of fuel. Since 10.8 cu. ft. CO_2 represented 22 per cent of the gases, 49.2 cu. ft. were produced altogether. On the other hand, 11.19 cu. ft. O_2 was necessary for the formation of CO_2 and CO, of which 4.94 were covered by the O_2 contained in the fuel, the remainder, as well as the 6.4 cu. ft. O_2 corresponding to 13.0 per cent O_2 in the gases, being taken from the air. Corresponding to this remainder, however, 48.0 cu. ft. N_2 plus the 13 per cent O_2 were introduced into the furnace, which alone nearly equals the 49.2 cu. ft. stated above.

The other possibility is the presence of products of distillation in the gases. To illustrate the probability of this assumption, I quote the table below, giving the products of distillation at various temperatures when heating a piece of red fir, according to an experiment of Boernstein:

Samples taken at	580-670,	670-760,	760-850 deg. F.
CO_2	53.5	55.0	28.0
Heavy hydrocarbons	0.2	1.5	5.0
CO	27.7	32.6	29.0
H_2	3.7	3.0	17.3
CH_4	14.9	7.9	20.6

These figures resemble more nearly those given by Mr. Gerend, except for the presence of O_2 in his analysis. Too bad he did not make them for hydrogen and hydrocarbons too.

To find some unburned hydrogen in the gases, though all the carbon was burned either to CO_2 or to CO, is quite a common occurrence, in spite of the fact that the ignition temperature of H_2 is somewhat lower than that of CO. Evidently this happens at single points of the furnace only.

All the possible gas analyses as given above, including those coming from pure distillation, do not justify the composition of gases as given by Mr. Gerend, for which reason it is to be assumed that his Orsat gave erroneous readings, an assumption confirmed by the discrepancy when compared with the results of titrating.

Orsats sometimes give too high readings as a consequence of poor design and hasty handling. Thus, if the bottom of the absorption pipette is flat instead of spher-

ical (see accompanying figure), and one of the glass tubes happens to stand coaxially with the U-tube connecting the two branches, the lower ends of the others resting on the flat bottom, the liquid in the central tube above the U-tube may sink so fast, as compared with the liquid in the pipette and the other tubes, that gas bubbles may escape through the U-tube into the open branch of the pipette, while the observer sitting on the other side of the Orsat believes that the liquid did not sink much and that the missing gas was all absorbed. This happens if the leveling bottle is lifted too quickly and cannot happen if the bottom of the pipette is spherical.

The fact that the 1/10 normal solution of KOH is weak will cause no error if a sufficient amount is used.

Newark, N. J. A. A. BATO.

Bridge Wall Height Determined by Gas Volume

HOW DO YOU determine the distance between the top of the bridge wall and the boiler shell for a return tubular boiler? S. H.

A. Figuring the distance between the bridge wall and the boiler shell on return tubular boilers is more or less arbitrary and depends upon operation conditions. If the boiler is set fairly high and the setting is designed to carry considerable overload, then the distance between the bridge wall and the shell will be greater than with boilers where operation is not expected to exceed rating.

Formerly, there was a rule of thumb which said that this distance should be one-seventh of the grate area, the flue area one-eighth and the chimney area one-ninth. In more modern practice this distance is usually figured at 20 to 25 per cent of the grate area. This, as you may see, permits the free passage of a greater volume of furnace gas.

The main purpose of the "bridge wall" is to prevent the fuel from dropping off the rear of the grates into the combustion chamber. Incidentally it tends to raise the temperature of the furnace by providing a radiating surface; it tends to throw the gas currents upwards and along the side of the boiler shell and, being an obstacle to the free flow of the gases, it tends to promote mixture of the gases and the air, thereby improving combustion.

Although useful in the return tubular boiler furnace, the bridge wall sometimes causes trouble. Clinkers adhere to it with a great deal of tenacity and must be pulled or pried loose when cleaning the fires, while ash accumulation upon the top gradually reduces the draft area. The gases are forced against the boiler shell by the bridge wall and this tends especially if the boiler is set low, to impair combustion and more than offset the tendency to improve it.

Heat Value of Solid and Liquid Fuels

WHY IS the heating value of oil so much higher than that of coal? W. J. M.

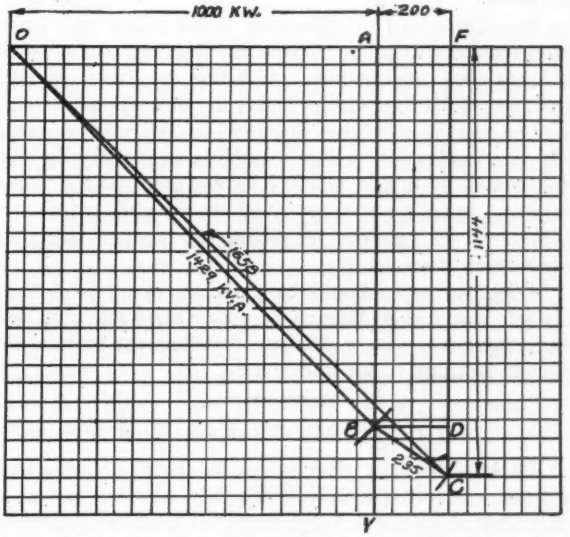
A. The heating value of oil is so much higher than that of the average coal because of the higher percentage of carbon and hydrogen. Taking an average coal of about 13,000 B.t.u., the percentage of carbon varies between 60 and 70. The hydrogen averages about five per cent. In most oils, the carbon averages about 85 per cent and the hydrogen about 12 or 13 per cent. This gives a heat value for oil of about 18,500 to 19,500 B.t.u.

The heating value of a pound of pure carbon is 14,600 B.t.u. and of a pound of pure hydrogen approximately 53,000 B.t.u. Multiplying 14,600 by the per cent of carbon in the fuel and adding to it the figure obtained by multiplying 53,000 by the per cent of hydrogen in the fuel will give the approximate heat value of most solid or liquid fuels.

Power Factor Can Be Determined in Advance

IS IT POSSIBLE to predetermine the power factor on a 550-v., 3-phase circuit, provided the appliances to be used are known in advance? L. B.

A. Yes, the power factor of a circuit can be predetermined provided the power factor of the proposed



THIS VECTOR DIAGRAM PROVIDES AN EASY METHOD OF ARRIVING AT THE VALUES NECESSARY FOR DETERMINING POWER FACTOR

load is known. If, for instance, on a circuit having a present load of, say, 1000 kw. operating at 70 per cent power factor, it is desired to add a 200-kw. induction motor with a power factor of 85 per cent, what will be the power factor of the circuit with the new load added? To solve this problem, refer to the accompanying diagram. Lay out the line OAF to scale, OA representing 1000 kw. and AF, 200 kw. Next draw the line AY perpendicular to OA at A.

With O as a center, strike an arc intersecting the line AY at B corresponding to the total reactive kv.a. of the circuit which is $1000 \div 0.7 = 1429$ kv.a.

Next construct BCD in a similar manner, representing the induction motor load which is to be added, with BD corresponding to 200 kw. and BC corresponding to $200 \div 0.85 = 235$ kv.a.

FC then represents the total reactive kv.a.

$FD = \sqrt{1429^2 - 1000^2} = 1020.$

$DC = \sqrt{235^2 - 200^2} = 124.$

$FC = 1020 + 124 = 1144.$

$OC = \sqrt{1200^2 + 1144^2} = 1658.$

The new power factor $= 1200 \div 1658 = 72.4$ per cent.

Condensate from the World's Power Plant

ANALYZED FOR QUICK STUDY AND COMPARISON. BY WILLIAM SIBLEY

Executives in Training

Obviously it is the duty of every manager to assist ambitious employes in progressing toward executive leadership. Any man in charge of other men can better give proper directions if he is well versed in the details of work which he is supervising and no mental training can take the place of hard won experience, hence foremen should always remember that training is primarily intended to supplement experience, not to replace it.

Major problems in all industries are reduction in cost, maintenance or increase in production and improvement of quality. In all of these, especially in reduction of cost, the lesser executives are of great importance.

It is important that the man fit his job so that labor replacement will be infrequent as this labor turnover is a large item of expense. Also the executive, in any position, should carefully train an understudy so that a man will be available to carry on the work regardless of vicissitudes or changes. This means day by day and month by month training in company policy, economy and handling of men. And the example set by the executives will go far in setting up proper spirit in the organization.

Each foreman should be given to understand that his job is secure so long as he makes good and that advancement depends on his own development and on his proper training of an understudy.

Imaginations Realized

Back in the days when executives wore burnsides and scorned cigarettes, nearly every factory office had as a wall adornment a "birds-eye view" of the plant. "Birds-eye" view was right because, in those days, the hot-air balloons carried only dare-devils and parachute jumpers, not skilled photographers equipped with expensive reflecting cameras. Seldom were those old-time birds-eye views true to life. Usually the actualities of dump piles, slag heaps and assorted rubbish were transformed by the retoucher's brush into self-conscious trees, beautifully-rippling flags and flowing fountains.

Singularly enough, these somewhat imaginary views are now coming to life. More and more employers are grasping that Mr. Keat's saying, "a thing of beauty is a joy forever" may profitably be completed thus, "and also stimulates endeavor." There is evident throughout the country increasing appreciation of the fact that attractive surroundings have an apreciable effect on the contentment and happiness of employes. Because this is reflected directly in better production, the value of beautifying industrial property is now conceded by the most unesthetic efficiency experts. Also, though not so readily measured in terms of tangible value, beautiful surroundings result in increased prestige and good will.

It is only common sense to avail ourselves of beauty wherever possible. Hundreds of plants possess considerable ground that might well be made attractive with blue grass instead of being allowed to yield its annual crop of ugly weeds. No one would be so uneconomic as to suggest the creation of a small edition of a public park but seldom is there good reason why a tree should not be planted, a border of shrubs established, or ivy started over a masonry wall or along a wire fence. Sumac trees are decorative in the extreme and will flourish in the most gaseous atmosphere on the poorest soil. To plant a few sumac in a remote corner of the yard will cost little in money but the planting will add of nature's loveliness to a spot that is, perhaps, quite prosaic. Elms are beautiful and hardy though much slower in growth. Another hardy tree that does well in poor soil and in close proximity to smoke and gas is the stately lombardy poplar. Why not one or two on the property?

If there is a protective fence about the property, a naked or somewhat ugly wall, consider the Virginia creeper, the English ivy, the rambler rose, the Japanese morning glory, or the woodbine, with its brilliant scarlet and its russet foliage.

A little planting and a little painting afford benefits all out of proportion to the expense involved and add to the joy of living of those working in the plant as well as to the public esteem for the management of the business.

Wherein Lies the Difference

Between the successful and the unsuccessful, the difference is largely a matter of vision. Uncounted millions saw apples fall from trees, but Newton had the vision to see that there must be a reason for such action. After countless thousands of old men had made their grandsons various types of kites, it remained for Curtiss and the Wright boys to ask why, to study how, and to do. Water has been boiling for ages and, wherever it boiled, there was always steam. But it was left to James Watt to ask why and, not getting a satisfactory answer, investigate for himself so that steam power might be harnessed, to the everlasting fame of himself and the boundless benefit to mankind.

A $5000-a-year employe of the greatest agricultural implement manufacturer in the world spent long evenings evolving two schemes whereby he might use, at no expense to himself or his company, the facilities of two other great corporations in advancing the interests of his company. The ideas were simple and they worked. Today he is a $10,000-a-year employe.

For one hundred years wire rope has been made in such a way that it would fly apart or "explode" when cut or broken. An engineer in the East believed that there was a way to remedy that internal stress of the metal and, when eliminated, produce a better wire rope. By a little mechanical device no larger than one's index finger, wire rope strands are now preformed and laid into place with the result that thousands of operatives are in less danger and hundreds of companies are making greater dividends through reduced overhead.

One great telephone and telegraph company recently envisioned this nation 50 yr. hence and they saw a population of 160,000,000 demanding a correspondingly

large number of instruments. Realizing that this would impose an almost impossible demand they, even now, have cables stretched across the continent sufficiently large to care for this increased population and are spending hundreds of millions in the effort to increase further the speed of transmission.

As stated above, success is largely a matter of vision —applied.

The Painting that Blooms in the Spring

That painting plays an important part in the preservation as well as the attractiveness of our property, no one will deny. And, while it is essential that we do what we can to make our buildings attractive and so far as possible a source of civic pride, it is the element of preservation that makes the periodic application of paint necessary.

Natural elements of wind, rain, sun, heat and cold never cease in their efforts to destroy. Unprotected from these elements, any material will rapidly deteriorate. Unpainted or unprotected wood permits the entrance of moisture, while the sun's rays have a tendency to draw that moisture out. This action, alone, will cause serious cracking and a general weakening of the material but would not be so serious were it not that the absorbed moisture, before being drawn out by the sun's heat, starts the process of decay. Hence the need for a protective covering, not only to wood but to practically all materials, since the principle of natural deterioration applies in a greater or lesser degree to iron, steel, concrete, clay products or slate.

Other elements of destruction such as dirt, dust, smoke and soot must be considered when the task of painting or resurfacing is assumed. Those artificial elements are more destructive to the general appearance of a structure than to its strength or durability but they do have a direct bearing upon the kind of paint to be used, if the best results are desired.

Just recently the Institute of Paint and Varnish Research has completed a long series of tests and experiments, the purpose of which was to determine the relative dirt-absorbing qualities of gloss and flat paints. The fact that these tests have rather upset some time-honored theories proves their value. It was found, for instance, that flat finishes absorb less dirt and dust than gloss surfaces, because, in a flat finish, little pigment is exposed, most of the oil having been absorbed by the covered material. While doubtless smoke particles, dust and dirt would find more ready lodging places on a flat finished surface, those particles are not absorbed as they are with gloss surfaces, for which reason they are dusted or blown off. This fact should have an important bearing on the selection of paint, for in localities where soot, smoke, dirt and dust are noticeably heavy, it would obviously be of advantage to employ flat-finish paints.

Then, too, in many industrial sections, the atmosphere is laden with acids and gases which react detrimentally upon the pigments contained in paint and actually effect a chemical change in color even after the paint has been applied. Along the Passaic River in New Jersey, as an instance, the acid and gas fumes contained in the atmosphere changed grays to blacks, yellows to pinks, browns to a purplish tint and whites to varying degrees of grays. Doubtless this action was more noticeable during the dry seasons, a year or two ago, but it remains that such color changes did occur and that for best results, any institution so located should take into consideration the air content when planning either office interior or plant exterior painting jobs. Various types and kinds of "gas-proof" paints are available from practically every reliable dealer or manufacturer.

All roofs, regardless of type, need periodic attention. Gravel roofs automatically relieve themselves of "paint" discussion, as do tile roofs. Those, however, should have inspection to bring into evidence the need for patching, re-tarring, or the replacement of broken tile shingles. Paper roofs should be recoated as a matter of routine, while all shingle surfaces should be painted for the sake of fire hazard reduction, if for no other reason.

In and about every plant, there is a great deal of metal employed and, generally speaking, every inch of this metallic surface should be afforded a protective coating. Indeed, unprotected metal surfaces contribute materially to excessive overhead and annually the replacement bill for such neglect reaches an enormous sum. This replacement cost, furthermore, could be almost entirely eliminated by the application of paint, since metal is a substance that, when protected with a film of paint, varnish or nickel, will last indefinitely. Since there is inherent in all metals the quality of expansion and contraction, such paint coverings should be elastic. It is good, of course, to apply paint to metal just as soon as deterioration or rust sets in but it is much better to make that application before the rust or corrosion becomes evident.

Transparent Steel

Recently, Doctor Karl Mueller, member of the staff of the Physical Technical Institute of Berlin, has succeeded in producing sheets of steel so thin that they are as transparent as the clearest glass, according to an announcement of that institute. The new method of making sheets of metal of unprecedented thinness seems likely to prove of far-reaching industrial as well as scientific importance.

Test plates used to determine the transparency of optical glass and which were ruled with cross lines 2500 to the sq. in., were photographed through such a metal sheet and, when enlarged to four hundred diameters, the scale lines showed distinctly, with no trace of distortion. This absence of aberration conclusively proves that the structure of the film was perfectly even and equal in all directions. The metal sheets are so thin that atoms will penetrate them without impediment, yet so strong that when fastened in a frame they may be bent (by blowing) to the extent of $\frac{1}{16}$ in. without rupture. The delicate sheets are made by depositing an extremely fine film of the metal on a smooth surface by means of electric current, then separating the film from the foundation on which it was fixed.

Such sheets will have an important place in many kinds of scientific and industrial research since they may be used as membranes for the separation of gases, or lend themselves to the progress of television and telephotography.

EDITORIAL COMMENT

Securing Ice Plant Economy

It is encouraging to find a small ice plant that has been remodeled with the idea in mind of installing no more new equipment than was absolutely necessary to give good economy, at the same time using much of the existing equipment, cutting down the electrical losses as far as possible and securing a convenient and simple layout.

This has been done in the ice plant of the Lima Ice & Coal Co., described in this issue. When this plant was remodeled, it already possessed an unusually large storage capacity, thus enabling it to operate with a good load factor, which was important since the power company's rate involved this item. It had the further advantage of 53-deg. condenser water. But it would have been easy, in remodeling, to spend large amounts of money in rebuilding the ice tank, in installing extra condensers, in providing separate motor drives for pumps and air compressors. Instead of this, an auxiliary brine cooler and a condenser installed outdoors raised the tank capacity, all the main units were driven from a single flywheel-type, synchronous motor, and various pieces of equipment from the old plant were used to good advantage.

Results obtained at this plant have seemed to confirm the good judgment of those who rebuilt it. Their plans for the future seem sound and practicable. We feel that a careful study of the details as given will repay every refrigerating engineer and will give him ideas that he can use in his own plant. Now is the time, while your plant is running along continuously under steady load, to analyze it for improvements to be made next winter. You can profit by the experiences of the Lima plant.

Public Utilities Recognized as Sound Investments

With the public utility commission as a buffer between the public and the managers of the utilities, a confidence in the utilities, particularly electric power companies, has grown up, that is well worth noting.

In all states where public utility commissions exist, the books of the operating companies are open to inspection by the commission and no company can legally issue stocks, bonds, mortgages or other securities without the consent of the commission. It must be able to show to the commission ability to meet all its financial obligations.

Under existing laws, public utility bonds are considered so sound that the Massachusetts mutual savings banks have conducted an active campaign to legalize investments in bonds of public utility companies. As a result a bill permitting such investments by banks has passed the Legislature, been signed by the Governor and will become a law within a few days.

As a rule, companies with stocks and bonds for sale dispose of them through some financial house which undertakes the marketing of the entire issue. Many companies, however, retain a portion of their securities for sale to their own customers believing that this policy creates better public relations than can be secured in any other way. Sale through a financial house usually gives a wider geographical distribution than can be secured through sales to customers and thus has the advantage of bringing in money from the outside to develop the community.

Business today is done on such a large scale that only comparatively few men are fortunate enough to own outright the company in which they are active. To those not so situated, the public utilities of the country offer an opportunity for investment which has every indication of security and brings a return considered fair by the public utilities commissions. Investment in these carefully scrutinized securities, bonds or stocks of established public utility companies, is a natural and desirable policy for power plant workers who earn their living in this industry and can thus become part owners in it.

Economies and Personal Efficiency

Efficiency is one of the most common, overworked and general terms in the engineer's vocabulary. From the simple overall efficiency, obtained from "gallons of water per bushel of coal," as expressed in Watt's day, subdivision after subdivision has taken place until efficiency without a number of limiting adjectives has little meaning.

We have boiler efficiency, thermal efficiency, Rankine cycle efficiency, efficiency referred to this, and efficiency referred to that, until we get into technicalities that mean little except to the engineer actually engaged in an intricate analysis of performance.

Where the manager is concerned only with the final result, overall efficiency, the operating engineer is concerned with the efficiency of each unit and the designing engineer is concerned with the efficiency of each part of the individual machine. Each division plays its part in bettering the overall efficiency although the layman, lost in a technical maze, considers it analogous to the physician's use of Latin for prescription writing.

Of the various terms, personal efficiency is the most difficult to define and evaluate, the one point where management either consciously, or unconsciously, enters into the details of production expense. Each employe "doing his most and best in the shortest time and easiest way to the satisfaction of all concerned" is a big item in the final result. Co-operation and development

can be built up by encouraging responsibility, promoting co-operation and intercourse of employes with similar developments, paying salaries that afford a comfortable living and allowing enough time for thought and development between duties.

Petty economy at the expense of personal efficiency is usually a dangerous method of lessening expenses. Dissatisfied employes are an expensive luxury and one fireman can deliberately waste more coal than a dozen turbine experts can save by years of experimental work. The best chief engineer in the land can do little with a plant unless he has the co-operation of the management in building up the personal efficiency or morale of his force.

I'm Sorry—I Forgot

The chap who says "I forgot" and expects to get away with it is as bad as the man who got famous for saying "I didn't know it was loaded."

To forget may be a simple enough thing but the proceedings at the inquest later on may be somewhat difficult and complicated, while as for the forgetting part of it, well, you know how you'll feel.

Whether it is a paying proposition to drive memory to do its full duty or to let each unthinking, haphazard moment take care of itself is not for the individual to decide. We do not live to ourselves nor for ourselves. Modern society is so complicated and we have to depend so much on each other that "I forgot" does not go.

The courts recognize such elements as negligence in operation and careless supervision. Usually the boss has to foot the bills but your particular "bull" may put innocent people in the hospital, not to mention black drapery.

When you concentrate on the job you force the mind to do its best. The funny part about that is that each time you do it, your mind grows better and stronger. Memory is automatically whipped into line and all the faculties are on the alert. In common language they call it "having your wits about you." The man who holds other lives subject to his being mentally alive has no right to take a chance; whether he is the boiler room foreman or the guiding mind of the Twentieth Century Limited, pulling twenty Pullman coaches of sleeping passengers.

Off Duty

"What ho! Standest thou not there like a dumbbell, knave. Snappest it up with yet another round on yon thumbscrew. Dost not observe the heretic winceth not? Bestir thyself, sluggard, or by the seven imps of Beelzebub, I'll sackest thee from out the Inquisitional Chamber."

"Holdest on, Yorick; be'est not unjust. See'st not yon thumbscrew's drawn tight and that yon devilish rack extendeth no further? Forsooth, 'tis not mine fault if this misbeliever's limbs stretcheth like gutta percha."

Even the torture chambers of old had their problems. However, the problem of wringing a confession from the lips of an obstinate heretic was nothing compared to the problems encountered in modern torture chambers.

Perhaps, you don't even know that there are such things in existence today. Well, there are, and if you ever stepped into the testing laboratory of a large manufacturing company you would discover that when it comes to devising instruments of torture, the modern scientist has the ancients backed clean off the map.

For these cruel men spend all their waking hours subjecting innocent raw material, steel, paper, copper and other things used in manufacture, to the most brutal ordeals imaginable. Even in the ancient horror chambers they never stretched a victim out just to see how much he would stretch before breaking, or let a weight fall on him to see how big a dent it would make, or squeezed him up to see how much he could be compressed. Yet, that's just the sort of treatment the modern testing laboratory gives the raw materials it receives, some of them haughty aristocrats worth their weight in gold. Whether they like it or not, they have to stand up properly under these rigid tests to prove their worthiness to be used in manufacture.

At times, some very neat problems arise in these laboratories. A case in point described in a recent issue of the Western Electric News is the problem of testing a Rockwell hardness tester which recently confronted the staff of the inspection laboratory of the Western Electric Co. at Hawthorne. This machine, it must be known, is used for ascertaining the hardness of metals by means of a penetrator which is pressed into the sample to be tested. A dial registers the hardness in proportion to the distance of penetration.

To arrive at a proper interpretation of the data taken on hardness testers at various testing laboratories throughout the country, it became necessary to determine accurately the pressures exerted by these machines. If they were not adjusted the same, it might happen that a supplier would test material and find it sufficiently hard, while the Hawthorne testers would reject it.

So the problem was put up to the Hawthorne laboratory staff, who, with their customary diabolical cunning, soon solved it—and in a very simple manner at that. In fact, they didn't do it at all, they let the testers do it themselves. Wise birds, these.

Instead of improvising levers and weights or employing spring compression, all very difficult to do in this particular instance, they merely hooked up a pair of testing machines into a bucking contest. The hardness tester's opponent was an Olsen tester, another interesting machine. Ordinarily, the Olsen tester is used for accurate testing of material under tension, but it is versatile and, being full of "pep," didn't mind doing a little extra work. By hooking the machines in opposition the pressure exerted by the Rockwell machine could be read on the dial of the Olsen. The Olsen is calibrated with standard weights and will record pressures on its weighing table to an accuracy of 1/10 of one per cent.

So the machines tested themselves. When the two machines were mounted so that the Rockwell machine became an integral part of the Olsen, the pressure of the Rockwell was read directly on the Olsen. Extremely satisfying checks were obtained in this manner. When brought to the attention of the testing laboratory of the American Brass Co. at Kenosha, Wis., it was thought to be of such value that they requested the Hawthorne laboratories to check up their Rockwell tester in this way.

Positive Lubrication for Diesel Engine Cylinders

FOR Diesel and other heavy oil engines, one of the most important requirements is correct lubrication of cylinder walls, without which satisfactory performance cannot be expected. Because of high compression

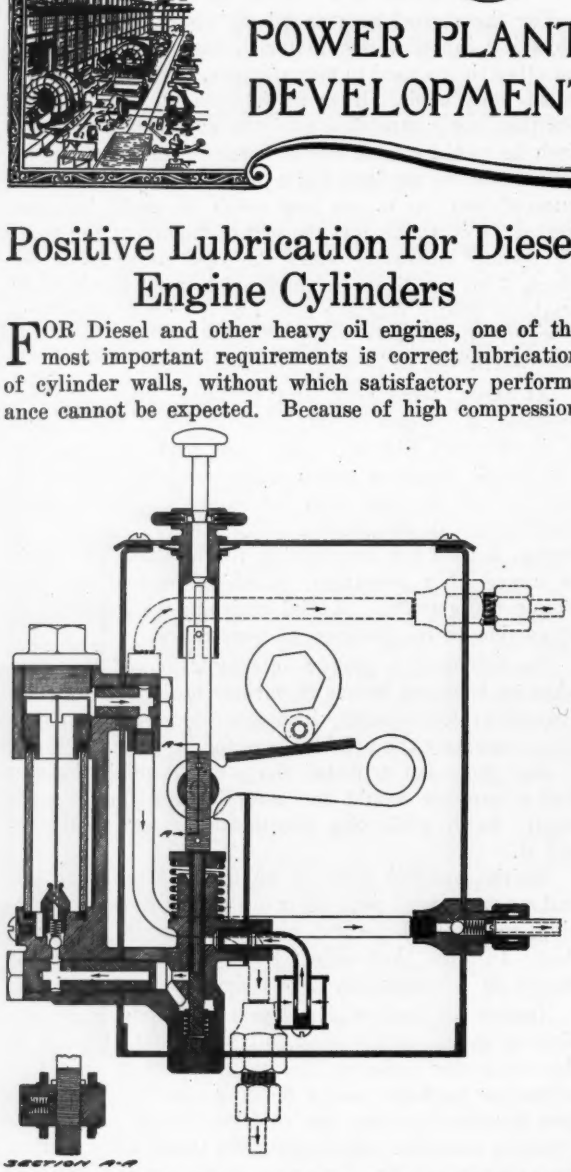


FIG. 1. POSITIVE FEED OF OIL THROUGH SIGHT GLASS IS MEASURED BY PLUNGER STROKE

and temperature, the problem is more serious than in gas or gasoline engines, and it is essential that the oil be delivered regularly, at the exact time desired but never in excessive quantity as a surplus may cause carbon and the gumming of valves and pistons, yet insufficient supply results in excessive wear and possibility of scored cylinders.

Forced feed is now almost universal practice with builders of heavy duty engines and is gradually being adopted for smaller sizes. For this purpose the Manzel Model 77 lubricator has been designed to force oil into the cylinders in measured quantities and at any desired point of the piston stroke regardless of viscosity of oil, engine speed or pressures in the cylinders.

This lubricator is built on the unit principle, i.e., an individual pump for each point to be lubricated but all assembled into a single casing. As shown in Fig. 1, each pumping unit has a single plunger, forced down by a cam lever and drawn up by a spring. The amount of oil pumped is fixed by the plunger stroke which is controlled by raising or lowering the cam lever by means of the regulator screw, adjustment being possible while the engine is running. Hand operation of the plunger is provided for flushing each cylinder when starting up the engine, or to fill oil pipes, also a hand crank for operating the shaft.

Cams are driven by a hexagon shaft which may derive its motion by ratchet, lever, belting or gearing from the shaft or other moving part of the engine. The

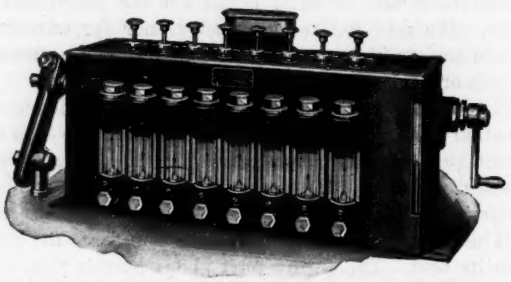


FIG. 2. UNITS AS ASSEMBLED FOR DRIVE BY RATCHET, BY HAND CRANK OR HAND PLUNGER

plunger opens and closes the inlet port and the outlet piston valve is opened by pressure and closed by a spring.

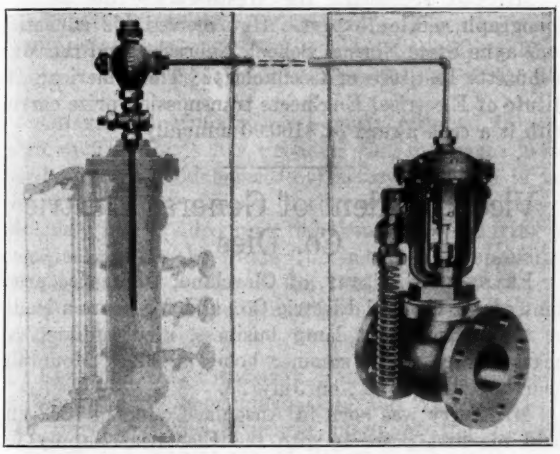
For pressures up to 400 lb. the oil is forced through glycerine in sight glasses, oil drops being guided by a wire so as not to touch the glass, as shown in Fig. 2. For higher pressures, up to 1500 lb., bullseye sight feeds are used. Although the oil passes through the sight glass in drops, it is obvious that, since the line from pump to point of lubrication is filled with non-compressible fluid, as much oil must leave the line at each stroke of the pump as is forced in, in spite of the interval between drops. Feed is, therefore, positive and exact with each stroke of the plunger.

Since the drive shaft may be driven from the engine by chain and sprochet or gears, exact timing of lubrication can be effected at any point of the piston stroke and cams for different cylinders can be mounted on the shaft at 45, 60, 90, 120 or 180 deg. apart, or any other arrangement desired by making special cams. Also, if desired, the driving shaft may be divided in the center, half the units being driven from each end so that each set can have a different timing by direct drive.

This device is a new product of Manzel Brothers Co., 327 Babcock St., Buffalo, N. Y.

Atlas Valve Co. Has New Boiler Feed Regulator

EMPLOYING the principle of pressure drop through orifices for regulating boiler feed, the Campbell regulator, made by the Atlas Valve Co., Newark, N. J., consists of a hollow casting with an inlet, an outlet, and a pressure port, properly connected to a feed-water control valve. To maintain the water level in the boiler at the middle gage cock, the lower end of the "supply pipe" extending down into the water column is made to terminate at that point. With the water in the water column slightly below the lower or open end of the supply pipe, steam passes into the regulator through a small orifice. The orifice is so small, the manufacturer states, that the pressure of the steam drops as it passes into the body of the regulator. It drops to about 10 per cent of the boiler pressure. This steam then passes out of the regulator body through a second orifice which is slightly larger than the inlet orifice. These orifices are so proportioned that the pressure in the regulator is maintained at about 10 per cent of the boiler pressure.



THIS BOILER FEED WATER REGULATOR IS EASILY MOUNTED ON THE WATER COLUMN AND IS CONNECTED TO THE CONTROL VALVE WHICH CAN BE PLACED AT ANY POINT IN THE FEED LINE

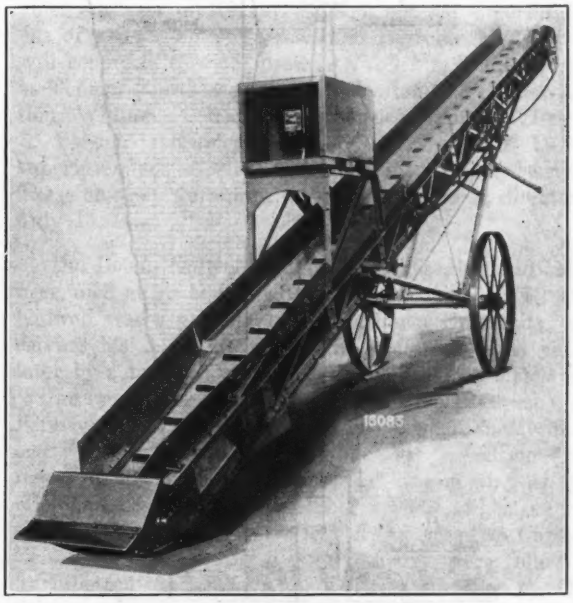
By means of the connecting pipe this reduced pressure acts on the diaphragm of the control valve shown at the right of the illustration. But 10 per cent of the boiler pressure is not sufficient to close the control valve, consequently that valve remains open and water continues to be fed into the boiler. As long, therefore, as the water in the boiler is below the entrance to the supply pipe, water is fed into the boiler.

As soon as the water reaches the inlet of the supply pipe hot water, instead of steam, flows into the regulator through the orifice. Immediately some of that water flashes into steam and a pressure within the regulator equal to nearly 60 per cent of the boiler pressure is created. When this high pressure acts on the diaphragm of the control valve, the valve closes and water flow to the boiler ceases.

As soon as the water level drops below the opening to the supply pipe, pure steam once more flows into the regulator, the pressure drops, the control valve opens and water is fed into the boiler. The steam or hot water which flows through the regulator is returned to the boiler through the heater or receiver. The control valve may be installed in the feed line at any point.

Jeffrey Company Improves Portable Conveyor

SEVERAL improvements have recently been made in the portable belt conveyor, manufactured by the Jeffrey Manufacturing Co., of Columbus, Ohio, for handling coal, coke and similar materials. These improvements have been designed with the idea of making a machine that is more suitable for road construction service, building material yards, and industrial plants



HOPPER BOTTOM CARS ARE CONVENIENTLY UNLOADED WITH THIS CONVEYOR

where it is desired to handle materials from hopper bottom railroad cars to storage piles or trucks, and for reclaiming from storage piles.

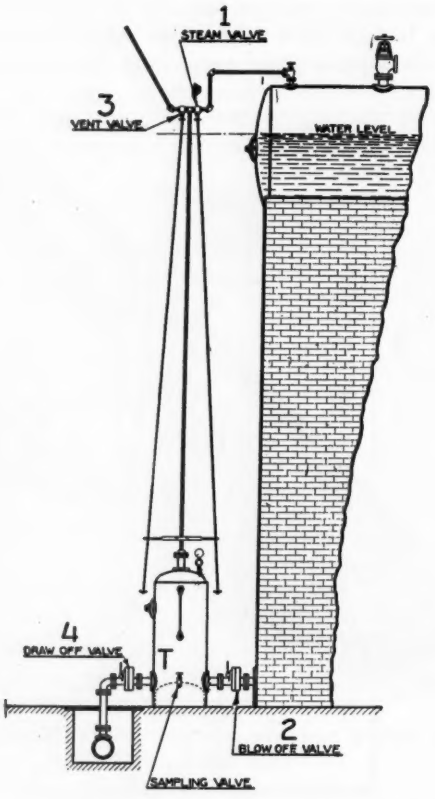
By referring to the accompanying illustration, it will be seen that steel side boards are provided, which are bent to extend under the side of the belt, forming with the belt a moving trough which provides a larger capacity and prevents lumps from rolling off. To support the loaded portion of the belt, an improved type of carrying idler has been provided. An extended and flared loading leg at the bottom, edged with belting material to form a seal with the moving belt is another improvement which has been made, and the flared hopper also centers the load on the conveyor. Another improvement is the provision of an efficient gate at the foot of the conveyor to prevent material from falling into the enclosed boot housing.

The improved Jeffrey Portable Conveyor is particularly adapted for handling materials from hopper bottom railroad cars.

Boiler Drawoff Increases Safety

BLOWING off boilers under full pressure is a process not liked and for good reasons. Hence, a process devised by Wylie G. Wilson, known as the "drawoff" method, is of special interest. The process is patented by the Everlasting Valve Co. under the name Boiler Drawoff, Wylie Wilson Process.

Between the boiler blowoff valve and discharge valve to the sewer, a closed tank is interposed, suitable for full boiler pressure. This tank has connection and shut-off valves to the boiler steam space and to atmosphere, as well as to blowoff valve and sewer.



WITH THIS TANK AND VALVES BOILER BLOWOFF IS MADE AT ANY VELOCITY AND VOLUME

With drawoff valve 4 and vent valve 3 closed, steam valve 1 is opened, admitting full boiler pressure to the tank. Blowoff valve 2 is then opened and the tank fills with water, which rises in the pipe to the level in the steam drum, when it comes to rest. This gives a slow blowoff, the flow being due to gravity head only, which many engineers believe to be advantageous.

Blowoff valve 2 is then closed in still water, the steam valve shut, vent valve opened to reduce pressure in the tank to atmospheric, and opening the drawoff valve allows the water to discharge.

Advantages claimed for this method are that velocity and volume of blowoff may be made at any predetermined values without undue wear on the valve. There is freedom from shock, saving in hot water, no steam discharged to the sewer and samples of blowoff water are easily taken for analysis.

The arrangement of valves as shown is standard but the steam and vent valves can be placed down at tank level if desired.

A. I. E. E. Awards Transmission Prize

ONE OF THE FEATURES of the recent convention of the American Institute of Electrical Engineers at White Sulphur Springs was the award of the 1925 transmission prize jointly to J. H. Cox and J. W. Legg, both of the Westinghouse Elec. & Mfg. Co. This award was made in recognition of a treatise on "The Klydonograph and Its Application to Surge Investigation," published in the journal of the A.I.E.E. for October, 1925.

The Klydonograph is a graphic instrument developed by Mr. Legg for the purpose of analyzing surges and other transients induced on high-voltage transmission lines. Mr. Legg is a specialist on oscilliography and has been with the Westinghouse Company since 1915. He received his preparatory training at the Worcester Polytechnic Institute, where he received his Bachelor of Science and electrical engineer degrees.

Mr. Cox represents the Westinghouse Co. as Klydonograph service expert. He received his education at Wayne State Normal School, Nebraska, and the Massachusetts Institute of Technology. The American Institute of Electrical Engineers transmission prize carries with it a cash award of $100.00 annually.

Vice President of General Electric Co. Dies

FRANKLIN S. TERRY, of Cleveland, Ohio, vice president of the General Electric Co., and for years a leader in the incandescent lamp business, died suddenly of heart failure at his summer home at Black Mountain, near Ashville, N. C., on July 23.

Mr. Terry was born in Ansonia, Conn., in 1862 and held his first position with the Electrical Supply Co. of Ansonia. In 1899 he organized the Incandescent Lamp Co. of Chicago and 4 yr. later took personal charge of that company. In 1901 the National Lamp Co., of which he was a founder, was purchased by the Sunbeam Co. A few years later the National Lamp Co. merged with the General Electric, Mr. Terry remaining with the National Lamp Works at Nela Park. He was also one of the organizers of the National Electric Light Association.

News Notes

CLIMAX ENGINES, built by the Climax Engineering Co., Clinton, Ia., have been approved by the Underwriters' Laboratories, Inc., as drive for fire protection purposes on 750 and 1000-g.p.m. pumps. Points passed on by the Laboratories were correct design, responsibility of makers and endorsement of users, good material and workmanship, interchangeability of parts, dependability for emergency service. Features contributing to these requirements are water circulating pumps, dual ignition, electrical starting equipment, vacuum fuel feed, fan-cooled radiator and flexible coupling to driven unit.

CONGRESS HAS PASSED a bill authorizing the construction of a steam power and heating plant for the Bureau of Standards, Washington, D. C. The station will be of brick and steel, 80 by 150 ft., and will be used for power and process work in connection with research at the bureau, d.c. and a.c. service, refrigeration, compressed air and vacuum service in addition to general heating. A. C. Brown is acting director of the bureau.

THE MUNICIPAL POWER AND LIGHT BUREAU, Los Angeles, Calif., has preliminary plans under way for an extension and improvement program to cost approximately $14,000,000. The work will include the construction of a new reservoir above present power plant No. 1, and the installation of another hydro-electric power unit to develop a capacity of about 47,000 hp. Other construction will be carried out along the line of the Owens River, for increase in power facilities and transmission service. The city has also been projecting plans for an auxiliary steam-operated generating station on site in the San Pedro Harbor district.

GEORGE L. BASCOME, former well-known consulting engineer in public utility circles and in the coal fields of northeastern Pennsylvania, has recently become affiliated with the National Valve & Manufacturing Co. of Pittsburgh, Pa. Mr. Bascome will travel the entire country in the capacity of Contact Engineer.

CHARLES J. MURRAY has recently resigned from the staff of The Linde Air Products Co., to become associated with the Oklahoma Contracting Co. He is now organizing a new division of that concern to engage exclusively in oxwelded pipe line construction, during his association with the Linde Co., in which he specialized in this class of work and has studied the construction problems connected with a large number of trunk line projects.

ELLIOTT Co. of Pittsburgh, Pa., now operating plants at Jeannette, Pa., Springfield, Ohio, and Wellsville, N. Y., has purchased the extensive plant of the Ridgway Dynamo and Engine Co. at Ridgway, Pa., with all its good will and assets. The Ridgway Co. has manufactured steam and electrical machinery for over 30 yr. and the addition of this plant to the facilities of the Elliott Co. will give it a complete group of power equipment including steam turbines, generators, steam engines, condensers, feed-water heaters, air ejectors, deaerators, motors and smaller accessories.

THE FURNACE ENGINEERING Co. announces that Ivan Stewart Forde has joined its organization as sales manager with headquarters at 5 Beekman St., New York City.

WILLIAM J. FOSTER, Schenectady, N. Y., engineer with the General Electric Co., received the honorary degree of D.S., at the recent commencement of Williams College, Williamstown, Mass.

PETER A. MCCARRON is now in charge of the interests of the Pennsylvania Power & Light Co., Allentown, Pa., in the Pottsville, Pa., district, including the Panther Valley section.

L. J. BELNAP, New York, has been elected president of the Worthington Pump & Machinery Corporation of that city to succeed C. Philip Coleman, who has become chairman of the board of directors. Mr. Belnap was formerly president of Rolls Royce of America, Springfield, Mass.

J. E. ALDRED, New York, president of the Consolidated Gas, Electric Light & Power Co., Baltimore, Md., and prominent in foreign power properties, received the honorary degree Eng.D., at the recent commencement at the Worcester Polytechnic Institute, Worcester, Mass. George I. Alden, for 27 yr. head of the mechanical engineering department at the institution, was also honored with a similar degree on the same occasion.

EDGAR ALLEGAERT, vice president in charge of electric operation of Public Service Electric and Gas Co. of New Jersey, has appointed Jacob T. Barron general manager of the electric department, and Marion Penn, chief engineer of Kearny Station, general superintendent of generation to succeed Mr. Barron. Mr. Barron will report to the vice president and Mr. Penn, as well as Thomas Sproule, general superintendent of distribution, William B. Hartshorne, service engineer, Hervey S. Vassar, laboratory engineer, and Frank J. Davis, superintendent of telephones, will report to Mr. Barron. These changes were approved by the board of directors, July 13.

DR. EDGAR KIDWELL, educator, philosopher and engineer, died at his home in Berkeley, Cal., on July 7. Dr. Kidwell was a graduate of Georgetown University, receiving his A. B. degree in '86, followed three years later by a master's degree and in '97 by a Ph.D. In '89 he received an M. E. degree from the University of Pennsylvania and for a year was instructor in Mechanical Engineering there. Following this he became Professor of Mechanical and Electrical Engineering at the Michigan College of Mines from 1890-98, when he resigned to become superintendent of the Arcadian Copper Co. Two years in the copper industry were followed by nineteen years as Pacific District Manager of The Stirling Co., and Babcock & Wilcox Co., after which he devoted his entire time to development of the Kidwell Boiler Co.

During his life time Dr. Kidwell received the Toner medal and various other medals for poetry, rhetoric, philosophy, mathematics, chemistry, mechanics and physics. He was an author of authority and wrote "Wooden Beams, Columns and Shafts," "The Efficiency of Built-Up Wooden Beams," "Tests of Stirling and B. & W. Boilers," "Stirling, a Book of Steam for Engineers," "Specifications and Drawings for Settings of Boilers," "The Kidwell Two-Flow Ring Circuit Boiler," as well as various articles for engineering magazines. He took an active interest in engineering development and was a member of the A. S. M. E., N. A. S. E., Milwaukee Eng. Ass'n and the Milwaukee Athletic Ass'n, still retaining his memberships after he had withdrawn from active participation in the Kidwell Boiler Co. about two years ago when retiring to his home in Berkeley.

THOMAS E. MURRAY, INC., announces that it has been engaged by the Pressed Steel Car Co., McKees Rocks, Pa., to handle the engineering work in connection with the installation of two 1300-hp. boilers with powdered

fuel equipment and a 3000-kw. turbo-generator with auxiliaries.

The New York Quinine & Chemical Corp., of Brooklyn, N. Y., has also engaged Thomas E. Murray, Inc., to draw plans and specifications for an addition to its present power plant.

COMBUSTION ENGINEERING CORP., LTD., Toronto, Canada, announces that Alfred J. T. Taylor, its president, has accepted the position of chief executive of the Underfeed Stoker Co., Ltd., London, England. Mr. Taylor is also president of the Ruths Accumulator Co., Inc., of New York, and will retain his connection with both of these firms.

THE THREE FELLOWSHIPS established by Gerard Swope, president of the General Electric Co., Schenectady, N. Y., at the Massachusetts Institute of Technology, Cambridge, to encourage honor students in the senior class of the departments of electrical engineering and physics to pursue graduate studies, have been awarded to the following students for the current year: Edward R. Wayne, Philadelphia, Pa., Department of Electrical Engineering; Joel Tompkins, Salem, Mass., same department; and John B. Coleman, Whitman, Mass., Department of Physics.

LEO SINGMASTER, formerly connected with the Pennsylvania Power & Light Co., Allentown, Pa., has been appointed manager of the municipal electric light and power plant at Souderton, Pa., to succeed Allen O. Langner.

THE OZARK HYDRO-ELECTRIC POWER Co. has been granted a permit by the Arkansas Railroad Commission to build a power dam on Crooked Creek, a tributary of the White River.

GARDNER C. ANTHONY, dean of the Tufts Engineering School, Medford, Mass., for the past 23 yr., or since the time of its organization, has recently tendered his resignation. It has been accepted and he will be relieved of active duty on Sept. 1.

ARTHUR W. BROWN, formerly manager of syndicate operations for the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been appointed assistant to the vice-president of the company with special executive duties. He will maintain headquarters at New York.

APPLICATIONS have been filed with the Federal Power Commission for the following developments: Tennessee Eastern Electric Co. for a dam 100 ft. high by 750 ft. long on the south fork of the Holston River about 10 mi. upstream from Kingston, Tenn.

Robert G. Gordon for dam and power plant at lock sites Nos. 9 and 12 on the Cumberland River near Carthage, Tenn., and Martinsburg, Ky., power to be sold to Kentucky Hydro Electric Co. and Kentucky Utilities Co.

Kentucky Hydro Electric Co. for a dam 38 ft. high and power house on the Cumberland River near Creelsboro at lock site 15.

Arizona Sodium Production Co. for a dam and reservoir on Aravalpa and Turkey Creeks near Pima, Ariz.

Wacker Light, Power and Water Co. for a power project along Ward Cove Creek, 8 mi. from Ketchikan, Alaska, with dam at the outlet of Lake Perseverance to regulate flow and a second dam at Ward Cove Lake with power house ½ mi. below.

CONSTRUCTION of a re-enforced concrete and steel sash building 25 by 45 ft. that will house a new 565-hp. Fulton Iron Works Diesel engine, has just been completed by the City of Idaho Falls, Idaho. This unit will be used as an auxiliary hydro-electric plant owned by the city, which has a capacity of 3000 kw.

PROFESSOR J. A. NEEDY, school of mechanical engineering, Purdue University, Lafayette, Ind., has recently resigned to become dean of engineering at the Ohio Northern University, Ada, Ohio.

STANLEY HEISLER, Bethlehem, Pa., heretofore connected with the Pennsylvania Power & Light Co., has been appointed distribution engineer for the Harrisburg Light & Power Co., Harrisburg, Pa., with headquarters in the last noted city, effective Aug. 1.

A. W. ROBERTSON, Pittsburgh, Pa., has been elected president of the Philadelphia Co., operator of public utility properties, to succeed Arthur W. Thompson, recently resigned to become president of the United Gas Improvement Co., Philadelphia, Pa. Mr. Robertson has acted heretofore as vice-president of the company, in charge of public relations.

THE FLORIDA POWER & LIGHT Co., Miami, Fla., is reported to be perfecting plans for expansion and improvement in its electric power, gas, ice and other utility properties. A new steam plant will be built at Punta Gorda; transmission lines will be extended to Daytona Beach, Holly Hill, Orange, and other towns. The ice plant at Cocoa will be completed and the one at Lake City enlarged and other improvements will be made.

AT A RECENT meeting, the Federal Power Commission authorized the issuance of a preliminary permit to the Wabash Hydro-Electric Co., Indianapolis, Ind., covering a power project to develop about 6000 hp. in the Wabash River, 6 mi. below Logansport, Ind. This project is the same as that for which a preliminary permit was issued to John A. Shafer, who has since surrendered the priority granted to him.

FOUR GIANT compressors installed in the pumping station at the new Harrison Gas Works of the Public Service Electric and Gas Co. of New Jersey went into service for the first time July 13. The compressors force the gas from the storage holders through the trunk lines for distribution to various cities and towns in the state.

Each compressor, driven by a three-stage condensing steam turbine, is of five-stage design. The gas passes through the stages successively, the pressure of the gas being increased at each until it is 15 lb. at the outlet of the final stage. Each compressor has a rotor made up of five separate encased impeller wheels, which revolve like so many electric fans on the same shaft. These impeller wheels are capable of various speeds, but make 4300 r.p.m. to produce 15 lb. pressure at a capacity of 25,000 cu. ft. a minute.

Gas is admitted to one end of the compressor, comes in contact with a revolving wheel and is set in motion. Thrown away from the wheel, the now active gas is forced through an orifice or channel to the next revolv-

ing wheel and so on through the five stages. The channels are narrower at the center than at the ends, and as the swirling gas is forced through its velocity is changed into pressure. After being discharged by the fifth wheel, the gas is forced through a 24-in. pipe into a 36-in. main, which is connected to the network of mains joining every point in the Public Service gas system.

PULVERZONE IS the name of a new type of coal-burning equipment recently put on the market by the CoKal Stoker Corporation, Chicago. This equipment consists of a power-feed stoker with an added feature of controlled air blast across the furnace front over the fire, by means of which the "fines" are burned in suspension, and a turbulence produced in the furnace. This blast also distributes the coarser fuel over the fuel bed, which gives the heat necessary for burning the fines and the spread coal.

AMERICAN BROWN BOVERI ELEC. CORP. announces that J. N. Mahoney, recently with the Condit Electrical Mfg. Co., Boston, Mass., has joined its organization.

THE W. B. FOSHAY Co., Minneapolis, Minn., has arranged to purchase the properties of the Globe Light & Power Co., Globe, Ariz., to be operated in conjunction with its various utilities under the name of the Peoples Light & Power Corp.

THE KENTUCKY HYDRO-ELECTRIC Co. has applied to the Federal Power Commission for a preliminary permit to construct a dam about 38 ft. in height with a power house on the Cumberland River, near Creelsboro, at the proposed lock site No. 15. Developed power will be used for public utility purposes.

THE BROAD RIVER POWER Co., Columbia, S. C., operated by General Gas & Electric Corp., has purchased the Enoree Power Co., operating a generating plant at Van Patton Shoals, S. C. Extensions and improvements will be made in the acquired property.

The Broad River Co. is also enlarging its steam plant on the Broad River by the addition of a 30,000-kw. generating unit.

THE AUSTIN Co., Cleveland, O., has been awarded a contract by the Continental Tool Co., Detroit, for a large new plant. This is to be a machine shop containing approximately 30,000 sq. ft. of floor space in a building of single-story design with a monitor extending down the length of the roof. Contract includes heating, lighting and plumbing work, and completion of the project is scheduled in 50 working days.

FURTHER TO ENSURE a substantial auxiliary electric service in the southern part of the State, a fourth cable tie-in between the Philadelphia Electric Co. and the Public Service Electric and Gas Co. in Camden, N. J., will be constructed, extending from the Delaware station of the Philadelphia company to the State Street substation of the Public Service in Camden. It will augment the three cables laid in 1923 from the Philadelphia station to Camden.

The new cable will have a capacity of about 12,000 kv.a., and will be of 350,000 circular mils. It will be 11 477 ft. long, 7302 ft. on the Philadelphia side, 3000 ft.. under the Delaware River and 11,166 ft. in Camden.

It is expected that the cable will be ready for use about October 1st of this year, according to John L. O'Toole, vice president of the Public Service Co.

IT IS INTERESTING to note that in the new 75,000-sq. ft. condenser, recently put in commission by the Southern California Edison Co. in its unit No. 9, the tubes of the condenser will be packed with a metallic packing. In this plant salt water is used for the circulating medium which makes it necessary to avoid so far as possible any galvanic action, and also possible deterioration of rubber or fabric packing.

THE PENNSYLVANIA Power & Light Co., Allentown, Pa., will soon proceed with the construction of a 20-story office building at Ninth and Hamilton Sts., Allentown, for which plans have been prepared by Helme & Corbett, 132 West 42nd St., New York, architects. The structure as now designed will be the tallest building in the city. The erection will be carried out by the Phoenix Utility Co., a subsidiary organization and completion is slated in the fall. All operating departments will be housed in the new structure.

IN A RECENT announcement of prizes to be awarded in 1926 by Harvard University, is inserted a prize of $2000, to be given for the campaign of the year most conspicuous for excellence of its planning and execution which seeks publicity for industrial products, primarily through the media of industrial trade or professional journals. Full details in regard to this prize and the method of entering an advertising campaign for the award can be had by writing to the committee on award of Bok prizes at Harvard University.

UNITED STATES Civil Service Commission announces that open competitive examinations will be held for positions of fuel engineer, $3800; associate fuel engineer, $3000; assistant fuel engineer, $2400. Ability to conduct laboratory and field fuel investigations, boiler tests, and so on, will be among the requisite qualifications. Applications for these positions must be on file, Washington, D. C., not later than Sept. 7. The examinations are to fill vacancies in the Bureau of Mines, Department of the Interior, for duty at Washington and Pittsburgh.

APPROXIMATELY $9,500,000 will be expended by the Public Service Electric and Gas Co. of New Jersey in carrying out its extensive substation and transmission program included in the budget of 1926. This distribution department portion of the total electric budget which involves something like $13,000,000, provides $6,500,000 for substations alone. Five new ones will be built in sections where present facilities are inadequate, seven others will be reconstructed, one will be enlarged and transformer and other equipment will be increased in twenty-six others to correct conditions where the demand has approached the capacity for which the stations were originally designed. While this entire work is provided for in the 1926 budget, it will be well along into 1927 before considerable of the work will be completed.

The transmission program, involving about $3,000,000, will provide for additional circuits in practically every division and will involve the installation of approximately 500,000 ft. of transmission cable and switching equipment as needed.

Books and Catalogs

CORROSION—Causes and Prevention. By Frank N. Speller. Size 6¼ by 9¼, cloth; 621 pages, 125 figures. Price $6, New York.

Written both for general reference and as a handbook for the engineer and architect who may desire practical knowledge of the developments in prevention of corrosion, this book is a comprehensive treatise on the subject. Although written with particular reference to ferrous metals there is an interesting discussion of electrolytic protection against corrosion of brass condenser tubes or other copper alloys. The book is divided into 15 chapters the first half discussing influencing factors both internal and external and the latter part dealing with preventative measure. Of particular interest to power plant operators is the discussion of the prevention of corrosion in feed-water heaters, economizers, boilers and condensers.

EVERY ABNORMAL disturbance in the running of a station has a cause which the operator would like to know and analyze. To stretch out the record during such a disturbance is the object of the Esterline-Angus Quick Trip Meter which is described in a bulletin issued by the Esterline-Angus Co., of Indianapolis, Ind. The bulletin tells how it is done and shows records made where 0.84 sec. is extended over a space of ¼ in. on the chart, the record going back to normal speed of 3 in. an hour after the disturbance was over.

THE MAYNE LOADER for loading broken ore and rock in mine tunnels, to eliminate the manual labor of hand-shoveling and reduce the number of men needed, is described in a bulletin issued by The Webster Mfg. Co., Chicago, Ill. This loader is a shoveling machine operating by compressed air and can be used for loading limestone, gypsum, zinc, lead or other materials.

RUGGLES-COLES DRYERS are attractively illustrated and described in a 30-page bulletin issued by Ruggles-Coles Division of Hardinge Co., York, Pa. These dryers are shown as applied to the drying of coal, cement materials, ores and concentrates, fertilizing materials and many others. Details of the equipment, tables of dimensions and methods of installing are given.

THE BROWN INSTRUMENT Co., Philadelphia, Pa., has just issued a large diagram showing the circuit of water, flue gas and steam through a power plant and illustrating the points at which the temperatures of these materials can be measured by suitable Brown pyrometers and recording thermometers, which are illustrated and described on the border of the chart.

"EDITOR'S REFERENCE BOOK on Cement and Concrete," issued by the Portland Cement Ass'n, Chicago, Ill., contains interesting data on the making of concrete and the various uses of it.

THE P&B OIL BURNER, a steam atomizing burner with only three parts, adaptable to any type of furnace, is described in a leaflet issued by its manufacturer, F. Beers & Co., Newark, N. J.

DIESEL ENGINES offer an opportunity to reduce power costs in almost every industry so that the new 32-page bulletin "Economy of Diesel Engine Power" issued by Fairbanks, Morse & Co. of Chicago, is of timely interest. The bulletin takes up an analysis of the various factors which affect the cost of power such as fuel cost, operating labor, maintenance, first cost and fixed charges, reliability and simplicity. The costs of a typical small Diesel power plant are analyzed and compared with similar costs for a steam plant.

Other chapters cover such points as the cost of purchased power, layout of the Diesel plant and the question of the fuel oil supply. Interwoven through this semi-technical story is a discussion of the application of Diesels in a wide variety of industries together with illustrations of Diesel-equipped plants.

AMERICAN DISTRICT STEAM Co., North Tonawanda, N. Y., announces that it has acquired the pattern equipment of the iron and steel body Nelson gate valves. They are described and illustrated in detail in bulletin No. 301, issued by the American District Steam Co.

GOETZE GASKET & PACKING Co., New Brunswick, N. J., has issued a new catalog describing Goetze gaskets for pipe, economizers, cylinder heads and many other applications.

WORM REDUCTION gears, oiled by a pressure system in place of a splash system and specially adapted for heavy service at high speed, are described in a leaflet issued by the De Laval Steam Turbine Co. of Trenton, N. J.

WILSON-SNYDER long-stroke boiler feed pumps are described and illustrated in bulletin W-79 B, issued by Wilson-Snyder, Pittsburgh, Pa. Advantages of the long-stroke pump are pointed out, tables of dimensions are given and illustrations of applications of these pumps.

IN WALWORTH bulletin No. 9, issued by Walworth Co., Boston, Mass., is discussed the standardized shrink head practice that has been adopted in its steel foundry to assure sound castings.

BACHARACH INDUSTRIAL INSTRUMENT Co., Pittsburgh, Pa., has begun publication of a house organ, the first number of which contains an article on "Development of Electric Gas Analysis." Copies of this house organ will be sent to readers upon request.

The Bacharach H-K optical pyrometer is described in bulletin No. 293 which discusses and illustrates the fundamental principle of the instrument and shows how it can be applied under various conditions.

IN AN ATTRACTIVE 24-page bulletin, Combustion Engineering Corp. describes and illustrates the C-E unit system for burning pulverized coal. This system has the Raymond impact mill, which is described in detail, and has been applied to all types of boilers and firing conditions, as illustrated in the bulletin.

MARINE OIL ENGINES for direct and electric drive are discussed in a two-color, 24-page bulletin just issued by Ingersoll-Rand Co., New York. The bulletin discusses in particular the single-acting, direct injection, 4-cycle, type P-R engine for direct-connected and electric-driven motor shifts emphasizing the single lever reversing engines for direct connection and non-reversing for electric drive with pilot house control.